TÜV Rheinland (Shanghai) Co., Ltd
莱茵技术（上海）有限公司
Solar/ Fuelcell Technologies
太阳能/燃料电池技术

Test Report
测试报告

Qualification of a Solar Collector in accordance with
太阳能集热器的测试参照标准
EN12975-1:2006+A1:2010 and ISO 9806:2017

TÜV Report No.:
TUV 报告编号: **50185939-001**

Shanghai /上海, 2018-10-18

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Report-No.:50185939-001

Qualification of a Solar Collector in accordance with

太阳能集热器的测试参照标准

EN12975-1:2006+A1:2010 and ISO 9806:2017

Client:客户：	Dezhou BTE Solar Co., Ltd. No 3387 Chongde First Avenue， Dezhou, Shandong 253000, P. R. China
TÜV Quotation No. 报价编号：:	52236472
TÜV Order No.: 项目编号：	154333482
Order of: 立项日期：	2018-05-24
Date of Receipt of Test Item:样品接收日期：	2018-08-02
Commencement of Test:测试开始日期：	2018-08-02
TÜV Client No.:客户编号：	678584
Project engineer:项目工程师:	Lily Chen +86 21 60814928
Business Field:业务领域：	Solar/ Fuelcell Technology
No of Pages:页数：	38
Appendix:附件：	29 to 38

Summary of collector performance test results: 集热器热效率测试结果：

Manufacturer 生产商	Dezhou BTE Solar Co., Ltd.		
Brand 品牌	BTE		
Collector type 集热器型号	BTE3.0-2		
Year of manufacture 生产年份	2018		
Length 长	2500.0 mm	Absorber area 吸收面积	2.840 m²
Width 宽	1200.2 mm	Aperture area 采光面积	2.833 m²
Height 高	80.0 mm	Gross area 总面积	3.001 m²
Weight (empty) 空重	49.47 Kg	Mass flow 质量流量	0.020 kg/(m²s)
Heat transfer medium 传热介质	Water	Test pressure 测试压力	150 kPa

Thermal performance 热效率

	Gross area (A_G) 总面积	Aperture area (A_a) 采光面积	Absorber area (A_A) 吸收面积
Conversion factor η_0	0.740	0.780	0.778
Heat transfer coefficient a_1	3.645 W/(m²K)	3.861 W/(m²K)	3.852 W/(m²K)
Temperature dependent heat transfer coefficient a_2	0.007 W/(m²K²)	0.008 W/(m²K²)	0.008 W/(m²K²)

Output power per collector unit 单块集热器的输出功率

	Irradiation 太阳辐射		
$T_m - T_a$ in K	400 W/m²	700 W/m²	1000 W/m²
10	729 W	1355 W	1981 W
30	506 W	1131 W	1757 W
50	265 W	891 W	1517 W

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1 Summary of test results 测试概览

Qualification of a Solar Collector in accordance with
EN12975-1:2006+A1:2010 and ISO 9806:2017

Manufacturer 生产商 : Dezhou BTE Solar Co., Ltd.
No 3387 Chongde First Avenue，
Dezhou, Shandong 253000,
P. R. China

Brand 品牌 : BTE

Collector type 集热器型号 : BTE3.0-2

Test 测试项目		Date 日期 Start 开始	Date 日期 End 结束	Summary of main test results 主要测试结果信息
Internal pressure 内压测试		2018-09-10		No visual damages
High-temperature resistance 耐高温测试		2018-09-01		No visual damages
Stagnation temperature 停滞温度		2018-09-13		No visual damages
Exposure 空晒测试		2018-08-02	2018-09-05	No visual damages
External thermal shock 外部热冲击测试	1st	2018-08-02		*908 W/m² No visual damages
	2nd	2018-08-23		*1008 W/m² No visual damages
Internal thermal shock 内部热冲击测试	1st	2018-08-21		*928 W/m² No visual damages
	2nd	2018-08-24		*986 W/m² No visual damages
Rain penetration 喷淋测试		2018-09-07		No visual damages
Freeze resistance 抗冻测试		NA		No visual damages
Mechanical load 机械载荷测试		2018-09-06 2018-09-07		When the negative pressure more than 1650Pa, the fastener is deformed and the collector separated from the mounting surface.
Thermal performance 热效率测试		2018-08-15	2018-09-05	No visual damages
Impact resistance 耐撞击测试		2018-09-07		The collector glass cover is broken when the height up to 1.2m.
Final inspection 终检		2018-09-07		Minor water ingress detected in collector box; The fastener is deformed when the negative pressure more than 1650Pa.

All above listed tests of the standard EN12975-1:2006+A1:2010 and ISO 9806:2017 were passed successfully in accordance with the criteria.以上所有测试项目已经通过EN12975-1:2006+A1:2010和ISO 9806:2017 标准的相关规定

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Shanghai, 2018-10-18

Project Engineer
项目工程师

Lily Chen

Assistant Project Manager
项目副经理

Cai Zhao

2 Setting of tasks 任务

A complete collector test in accordance with EN12975-1:2006+A1:2010 and ISO 9806:2017 of the collector BTE3.0-2 from Dezhou BTE Solar Co., Ltd. should be performed with the aim of Solar Keymark certification.

德州金亨新能源集热器BTE3.0-2为申请Solar Keymark证书而根据EN12975-1:2006+A1:2010和ISO 9806:2017标准进行的完整测试.

3 Basis of testing 测试依据

EN12975-1:2006+A1:2010 *"Thermal solar systems and components – Collectors – Part 1: General requirements"*

EN12975-1:2006+A1:2010 太阳能系统和部件 集热器 第一部分：基本要求.

ISO 9806:2017 *"Solar energy-Solar thermal collectors-Test method "*

ISO 9806:2017 *太阳能-太阳能集热器-测试方法.*

Solar Keymark – Specific Scheme Rules v31 March 2018: *"Specific CEN Keymark Scheme Rules for Solar Thermal Products"*

Solar Keymark -2018 年 3 月 v31 的特殊规定：*CEN 对于太阳能光热产品的特殊规定.*

4 Sampling 抽样

Prototype samples 样机抽样	○
Samples from pilot production 实验性产品中抽样	○
Samples from serial production 生产线抽样	◙
Selection of test samples acc. to Solar Keymark scheme rules 根据 SK 相关规定进行抽样	◙
Random selection of test samples acc. to SRCC scheme rules 根据 SRCC 相关规定进行抽样	○

5 Description of the collector construction 集热器基本信息

Manufacturer 生产商	Dezhou BTE Solar Co., Ltd.
Brand name 品牌	BTE
Collector Type 型号	BTE3.0-2
Category 类型	Flat plate covered
Date of manufacture 生产日期	2018
Serial number 序列号	20180704-5，20180704-8
Drawing numbers 图纸编号	JH06XX-T/L/X-22dN-L×W×80-GC-X, T/L/X-22dN-L×W-GCX, 22dN-L×W-GCX, JH-P-JG-Ø22×0.8×D3, JH-P-PG-Ød×0.6×Lp, JH-P-XRB-Wx×Lx_2, JH-P-BK-JH06-L-GC-01, JH-P-BK-JH06-W-01, JH-P-BK-JH06-W-02, JH-P-YT-W,JH-P-YT-L-01, JH-P-BW-BLM-30×Ww×Lw,JH-P-BK-DB-Wb×Lb-01, JH-P-GHBL-3.2×Wg×Lg,JH-P-BZ-W×L, JH06XX-L×W-80-GC-01

Collector & construction:

Gross dimensions l x w x t [mm] 总面积尺寸	2500.0 x 1200.2 x 80.0 ①
Normative Absorber dimensions l x w [mm] x no. of fins 有效吸收面积尺寸	2453.4 x 1157.4 x 1.0 ①
Physical Absorber dimensions l x w [mm] x no. of fins 额定吸收面积尺寸	2453.4 x 1157.4 x 1.0 ①
Aperture dimensions l x w [mm] x no. glazes 采光面积	2454.4 x 1154.4 x 1.0 ①
Gross/ Aperture/ Absorber area [m²] 总面积/采光面积/吸热体面积	3.001 / 2.833 / 2.840 ①

① Determinate by test laboratory 由测试实验室确认
② Reviewed manufacturer information 由厂家审核过的信息
③ According to manufacturer information 根据厂家信息

Weight empty [kg]空重	49.47 ①
Fluid content [l]流体含量	2.1 ①

Absorber:吸收体

Construction type 结构类型	Flat plate absorber ②
Absorber Material 吸热体材料	Aluminum ②
Absorber Grid 吸热体序列	Serial ②
Absorber thickness [mm] 吸热体厚度	0.42 ①
Effective Surface 有效涂层	One side ②
Surface treatment 表面处理	Selective coated ②
Absorptance [ ] 吸收比	0.92 ③
Emittance [ ] 发射比	0.060 ③

Absorber Piping:吸热体管路

Collector connection type / dimension / numbers 集热器接口/尺寸/数量	External thread / ¾" / 4 ②
Header tube material / dimension 流道材料/尺寸	Copper / 1263 / 22.00 ②
Riser tube-header / tube-Absorber connection 排管-集管连接/ 排管-吸热体连接	Brazed / laser-welding ②
Riser tube material / $Ø_{outer}$ / thickness / overall length [mm] 排管材质/直径/厚度/长度	Copper / 10 / 0.62 / 2377 ②
Number and Distance [mm] of riser tubes or fins on center position 排管数量以及间距	10 / 109.8 ①

Cover:玻璃盖板

Number of covers 数量	1 ①	
Glazing to absorber space 玻璃盖板与吸热体间距	33 (measured on one point) ①	
	Glass 1	Glass 2
Length / width or $Ø_{outer}$ / thickness [mm] 长度/宽度（或者直径）/厚度	2480.0 / 1180.0 / 3.2 ①	-

① Determinate by test laboratory 由测试实验室确认

② Reviewed manufacturer information 由厂家审核过的信息

③ According to manufacturer information 根据厂家信息

Material / surface and coating 材质/表面处理以及涂层	Glass / clear ②	-
Transmittance factor [ ] 透射比	0.92 ③	-

Casing: 边框（或者联箱）

Enclosure L x W x T [mm] 边框（或联箱）	2500 / 1200 / 80 ①	
Enclosure material 材质	Aluminum alloy ②	
Enclosure backside material 背板材质	Color galvanized steel ②	
Frame fastening method 支架固定方式	Wire crimp connection ②	
Insulation 保温	Primary Material 第一层	Secondary Material 第二层
Material 材质	Glass wool ②	-
Thickness [mm]厚度	30 ①	-
Material thermal conductivity [W/Km²] 材料导热系数	0.042 ③	-
Lateral insulation 侧面保温	Primary Material 第一层	Secondary Material 第二层
Material 材质	Polyester cotton ②	-
Thickness [mm]厚度	15 ①	-
Material thermal conductivity [W/Km²] 材料导热系数	0.035 ③	-

Sealing`s: 密封材料

Frame – Cover 边框-盖板	Silicon based ②
Frame Corner or side caps 边框-端盖	Silicon based ②
Frame - back sheet 边框-背板	Silicon based ②
Grommet header tube 端盖-流道	Silicon based ②
Grommet evacuated tube 联箱-真空管	-
Evacuated tube closure 真空管端部	-

① Determinate by test laboratory 由测试实验室确认
② Reviewed manufacturer information 由厂家审核过的信息
③ According to manufacturer information 根据厂家信息

Limit values (given by manufacturer):限值（生产商提供）

Max. operating temperature [°C] 最大操作温度	99 ③
Maximum operating pressure [kPa] 最大操作压力	1000 ③
Recommended Heat transfer medium 建议换热介质	Water / water glycol mixture / propanetriol solution ③
Recommended operating mass Flow [l/(m²h)] 建议流量	0.015-0.06 ③
Tilt angle limits [°] 倾角范围	0 to 90 ③
Collector mounting 安装方式	Wall / on roof / in roof / flat roof ③
Other limitations 其他限定	NA

① Determinate by test laboratory 由测试实验室确认

② Reviewed manufacturer information 由厂家审核过的信息

③ According to manufacturer information 根据厂家信息

Instruction/installation manual: 操作/安装手册
Installation manual is reviewed to the requirements of EN12975-1:2006+A1:2010
安装手册根据 EN12975-1:2006+A1:2010 的要求进行审核

	Comments 备注	Fulfilled 满足
Dimensions and weight of the collector, instructions for transport and handling thereof 集热器尺寸和重量及运输、操作说明		Yes
Description of the assembly procedure 组装流程说明		Yes
Recommendations regarding lightning protection 关于防雷击的建议		Yes
Instructions for connecting collectors to each other and for connection of the collector field to the heat transfer circuit as well as dimensions of tube connections in collector groups up to 20 m² 多个集热器单元组合到一起直到 20 ㎡的连接方式		Yes
Recommendations regarding the usable heat transfer media (also with regard to corrosion) as well as precautionary measures which are to be taken for filling, operation, servicing and maintenance 可用传热介质的相关建议（包括腐蚀）和充水、操作、服务及维修时的防护措施		Yes
Maximum operating pressure, pressure loss as well as largest and smallest tilt angles 最大操作压力，最大和最小倾角,压力降		Yes
Permissible wind and snow load 允许的风或雪负荷		Yes
Maintenance requirements 维修要求		Yes

Collector type plate: 集热器标签
Collector marking is reviewed to requirements of EN12975-1:2006+A1:2010
集热器标签根据 EN12975-1:2006+A1:2010 的要求进行审核

	Comments 备注	Fulfilled 满足
Name of the manufacturer 生产商名称		Yes
Type of collector 集热器型号		Yes
Serial number 序列号		Yes
Year of manufacture 生产年份		Yes
Gross collector area 总面积		Yes
Dimensions of the collector 集热器尺寸		Yes
Maximum operating pressure 最大操作压力		Yes
Stagnation temperature, at 1000 W/m² and 30 °C 1000 W/m² 和 30 °C 时的停滞温度		Yes
Volume of the heat transfer fluid 传热流体体积		Yes
Empty weight of the collector 空重		Yes
Manufactured in: …生产地		Yes
Marking durability 标签耐久性		Yes

6 Execution and evaluation 测试与评估

6.1 Visual inspection 外观检查

Date 日期	2018-08-02	Tester 测试员	Jinping Yang
Internal barcode no. 内部编号	Serial no. 序列号	Description of defects 缺陷描述	
A000785969-001	20180704-5	No visual damages	
A000785969-002	20180704-8	No visual damages	

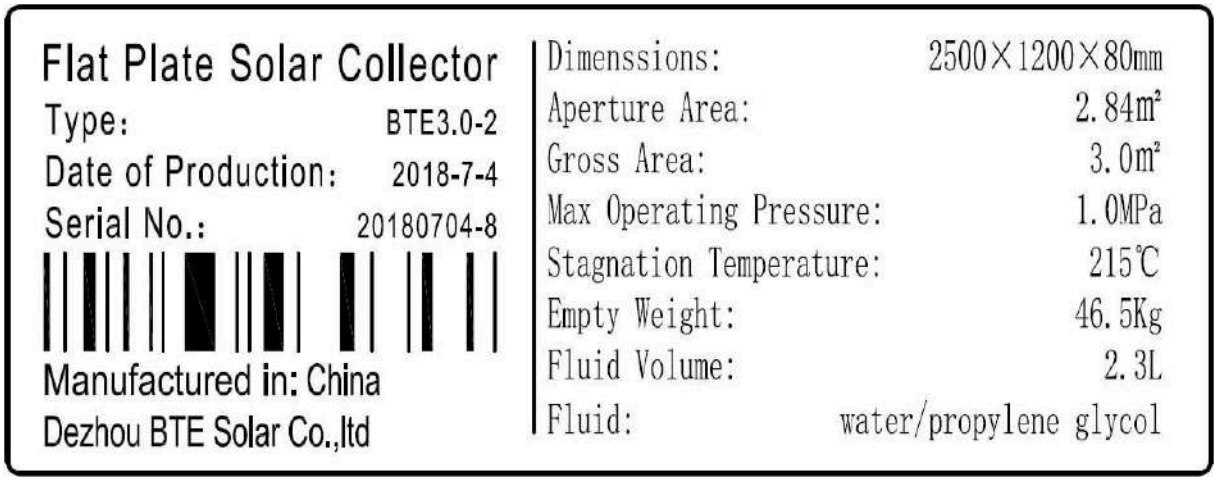


Fig. 1: sample label
样品标签

6.2 Internal pressure test 内压测试

6.2.1 *Collector type 集热器类型*

Absorber material 吸热体材质	◙ Inorganic 无机	○ Organic 有机
Maximum collector operating pressure specified by manufacturer [kPa] 生产商指定最大集热器操作压力	1000	
Serial no. 序列号	20180704-5	

6.2.2 *Test conditions 测试条件*

Date 日期	2018-09-10	Tester 测试员	Jinping Yang
Test temperature [°C] 测试温度	25.0		
Test pressure [kPa] 测试压力	1548.9		
Test duration [min] 测试时间	15		
Pressure difference [kPa] 压力差	11.6		

6.2.3 *Test results 测试结果*

Details of any observed or measured leakage, swelling or distortion and problems which according to 6.4 of ISO 9806:2017 are to be classified as “severe”. 根据 ISO 9806:2017 第 6.4 部分所观察或测量到的任何泄露、膨胀、变形等问题细节要归为“严重”.
No visual damages

6.3 High temperature resistance test 耐高温测试

Serial no.序列号		20180704-5	
Date 日期	2018-09-01	Tester 测试员	Jinping Yang

6.3.1 Method used to heat collector 测试方法

Test performed with outdoor exposure / solar simulator 室外暴晒/太阳模拟器	outdoor

6.3.2 Conditions for testing high temperature resistance 耐高温测试条件

Collector tilt angle [° from horizontal] 集热器倾角[从水平面]	30
Average irradiation during test [W/m²] 测试期间的平均太阳辐射	1027
Average ambient air temperature [°C] 平均环境温度	31.5
Average ambient air speed [m/s] 平均环境风速	0.9
Duration of test [min] 持续时间	60

6.3.3 Test results 结果

Details of any observed or measured degradation, distortion, shrinkage or out gassing and problems which according to 9.4 of ISO 9806:2013 are to be classified as “severe”. 根据 ISO 9806:2013 第 9.4 章所观察或测量到的任何泄露、膨胀、变形等问题细节要 归为“严重”.
No visual damages

6.4 Stagnation temperature 停滞温度

Serial no.序列号		20180704-5	
Date 日期	2018-09-13	Tester 测试员	Jinping Yang

6.4.1 Method used to heat collector 测试方法

Test performed with outdoor exposure / solar simulator 在户外暴晒/太阳模拟器进行测试	outdoor

6.4.2 Conditions for testing stagnation temperature 停滞温度测试条件

Collector tilt angle [° from horizontal] ° 集热器倾角（从水平面）	30
Average irradiation during test [W/m²] 测试期间平均太阳辐射	914
Average ambient air temperature [°C] 平均环境温度	31.0
Average ambient air speed [m/s] 平均环境风速	1.0
Absorber temperature [°C] 吸热体温度	198.6

6.4.3 Determination of stagnation temperature 停滞温度的确定

Stagnation temperature for ambient conditions of 1000W/m² and 30°C (determination acc. to EN 12975-2:2006, Annex C) 停滞温度 在辐射为 1000W/m² 且环境温度为 30°C 时（根据 EN 12975-2:2006 附录 C 进行确定）	213.4

6.4.4 Test remarks 备注

Requisite additional information for stagnation temperature: 停滞温度必须的附加信息：
NA

6.5 Exposure test 暴晒测试

Serial no.序列号	20180704-5	
Date begin/ end 开始/截止日期	2018-08-02	2018-09-05
Tester 测试员	Jinping Yang	

6.5.1 Test conditions 测试条件

Collector tilt angle [° from horizontal] 集热器倾角（从水平面）	30	
Total no. of test days and radiation energy [MJ/m²]总测试天数和总辐射	34	635.9
No. of days with more than 14 MJ/m² 超过 17MJ 的天数	20	
No of rain days and total rainfall [mm] 下雨天数及总降雨量	14	107.4
Time period with G>900 W/m² & ta>15°C [h] 辐射大于 900 W/m² 且环境温度大于 15°C 的时间	30.3	
	minimum value 最小值	maximum value 最大值
Ambient temperature of test days [°C] 测试日内环境温度	16.1	37.6
Ambient temperature during high irradiation > 900 W/m² [°C] 辐射大于 900 W/m²的环境温度	28.4	33.3
Total daily rainfall [mm] 总日降雨量	0.0	26.1

6.5.2 Test results 测试结果

Details of any observed or measured problems or failures which according to 10 of ISO 9806:2017 are to be classified as “severe”. 根据 ISO 9806:2017 10 章所观察或测量到的任何问题或失效细节归为“严重”.
No visual damages

For more details about exposition test see Appendix 2: Climate data.

对于暴晒测试的更多详细信息请参照附录 2：天气数据

6.6 External thermal shock test 外部热冲击

6.6.1 Test conditions 测试条件

	1st shock 第一次冲击		2nd shock 第二次冲击	
Test performed with outdoor exposure / solar simulator 在室外/太阳模拟器进行测试	outdoor		outdoor	
Serial no.序列号	20180704-5			
Date 日期	2018-08-02		2018-08-23	
Tester 测试员	Jinping Yang		Jinping Yang	
Collector tilt angle [° from horizontal] 集热器倾角（从水平面）	30		30	
Irradiation G^*_{min} & G^*_{mean} [W/m²] 最小和平均太阳辐射	908	1011	1008	1023
Ambient air temperature $t_{a\,min.}$ & $t_{a\,mean}$ [°C] 最小和平均环境温度	31.39	32.08	30.29	30.87
Period during which steady state conditions were maintained prior to shock [min] 在冲击之前的稳定状态维持时间	60		60	
Water spray mass flow rate [kg/(sm²)] 测试流体质量流量	0.047		0.049	
Water spray temperature [°C] 喷淋水温	22.8		21.8	
Spraying duration [min] 测试持续时间	15		15	

6.6.2 Test results 测试结果

Details of any observed or measured cracking, distortion, condensation, water penetration or loss of vacuum found and problems which according to 11 of ISO 9806:2017 are to be classified as “severe”. 根据 ISO 9806:2017 第 11 章所观察或测量到的任何破裂、变形、凝结、渗水、失去真空等问题细节要归为“严重”.
No visual damages

6.7 Internal thermal shock test 内部热冲击

6.7.1 Test conditions 测试条件

	1st shock 第一次冲击		2nd shock 第二次冲击	
Test performed with outdoor exposure / solar simulator 在室外/太阳模拟器进行	outdoor		outdoor	
Serial no.序列号	20180704-5			
Date 日期	2018-08-21		2018-08-24	
Tester 测试员	Jinping Yang		Jinping Yang	
Collector tilt angle [° from horizontal] 集热器倾角（从水平面）	30		30	
Irradiation G^*_{min} & G^*_{mean} [W/m²] 最小和平均太阳辐射	928	992	986	996
Ambient air temperature $t_{a\ min.}$ & $t_{a\ mean}$ [°C] 最小和平均环境温度	31.28	32.12	29.46	30.35
Period during which steady state conditions were maintained prior to shock [min] 冲击前稳态维持的时间	60		60	
Water spray mass flow rate [kg/(sm²)] 测试流体质量流量	0.035		0.036	
Water spray temperature [°C] 水温	21.7		22.1	
Spraying duration [min] 测试持续时间	5		5	
Absorber temperature after spraying [°C] 测试后吸热体温度	-		-	

Requisite additional information for internal thermal shock test:

内部热冲击必须的附加信息：

NA

6.7.2 Test results 测试结果

Details of any observed or measured cracking, distortion, condensation, water penetration or loss of vacuum found and problems which according to 12 of ISO 9806:2017 are to be classified as “severe”. 根据 ISO 9806:2017 第 12 章所观察或测量到的任何破裂、变形、凝结、渗水、失去真空等问题细节要归为“严重”.
No visual damages

6.8 Rain penetration test 淋雨测试

Serial no.序列号	20180704-5
Date 日期	2018-09-07
Tester 测试员	Jinping Yang

6.8.1 Test conditions 测试条件

Collector mounted on:集热器安装在	Open frame
Collector tilt angle [° from horizontal] 集热器倾角（从水平面）	30
Detection of ingress of water:检查是否进水	By weighing the collector
Water spray flow rate [kg/(s*m²)]流量	0.046
Spraying duration [h]持续时间	4
Weight difference before and after testing[kg]	0.0814

6.8.2 Test results 测试结果

Details of any problems which according to 13 of ISO 9806:2017 are to be classified as “severe”. 根据 ISO 9806:2017 第 13 章的相关问题细节归为“严重”.
No visual damages

6.9 Mechanical load test 机械载荷测试

Serial no.序列号	20180704-5
Date 日期	2018-09-06(positive) 2018-09-07(negative)
Tester 测试员	Jinping Yang

6.9.1 Positive pressure test of the collector cover 集热器盖板正压测试

Method used to apply pressure 适用的方法

○ Suction cups 吸盘 ◙ Loading with water 用水压

Maximum pressure load [Pa]最大压力	2200
Remaining deflection [mm]形变量	-

6.9.2 Negative pressure test of collector 集热器负压测试

Method used to apply pressure 适用的方法

○ Suction cups 吸盘 ◙ Loading with water 用水压

Maximum pressure load [Pa]最大压力	1650
Remaining deflection [mm]形变量	-

6.9.3 *Test results 测试结果*

Details of any damage to the collector cover, cover fixings or mounting fixings and problems which according to 15 of ISO 9806:2017 are to be classified as “severe”: 根据 ISO 9806:2017 第 15 章的任何集热器盖板、盖板配件或紧固配件损坏或问题细节归为“严重”.
When the negative pressure more than 1650Pa, the fastener is deformed and the collector separated from the mounting surface.

6.10 Impact resistance test using steel ball 用钢球做抗撞击测试

Serial no.序列号	20180704-5
Date 日期	2018-09-07
Tester 测试员	Jinping Yang

6.10.1 Test conditions 测试条件

Diameter of ball: 33.3 mm
钢球直径

Mass of ball: 152g
钢球质量

◙ vertical impact 垂直撞击 ○ horizontal impact 水平撞击

Maximum height of drops [m] 最大下降高度	No. of drop tests 下降次数
0.4	4
0.6	4
0.8	4
1.0	4
1.2	4
1.4	
1.6	
1.8	
2.0	

6.10.2 Test results 测试结果

Details of any damage to the collector and problems which according to 16 of ISO 9806:2017 are to be classified as “severe”. 根据 ISO 9806:2017 第 16 章观察到的任何集热器损坏和问题细节要归为“严重”.
The collector glass cover is broken when the height up to 1.2m.

6.11 Final Inspection 终检

Serial no.序列号	20180704-5
Date 日期	2018-09-07
Tester 测试员	Jinping Yang

6.11.1 Test results 测试结果

	Collector component 集热器部件	Potential problem 潜在问题	Evaluation 评价
a)	Collector box, fasteners 集热器联箱、紧固件	Cracking, warping, corrosion, rain penetration 破裂、弯曲、腐蚀、渗水	1
b)	Mountings, structure 支架、结构	Strength, safety 强度、安全性	1
c)	Seals, gaskets 密封、垫圈	Cracking, adhesion, elasticity 破裂、粘附、弹性	0
d)	Cover, reflector 盖板、反光板	Cracking, crazing, buckling, delamination, warping, out gassing 破裂、碎裂、屈曲、分层、扭曲、漏气	0
e)	Absorber coating 吸热体涂层	Cracking, crazing, blistering 破裂、碎裂、起泡	0
	Absorber tubes and headers 吸热管和管头	Deformation, corrosion, leakage, loss of bonding 变形、腐蚀、泄露、失去粘合	0
	Absorber mounting 吸热体安装	Deformation, corrosion 变形、腐蚀	0
f)	Insulation 保温材料	Water retention, out gassing, degradation 渗水、外漏、退化	0

Evaluate each potential problem according to the following scale:
根据下列形式评价每一个潜在问题

0 No problem没有问题
1 Minor problem较小问题
2 Severe problem严重问题

- Inspection to establish the condition was not possible.
  检验建立的条件是不可能的.

Requisite additional information for final inspection:
终检必要附加信息：

Minor water ingress detected in collector box;

The fastener is deformed when the negative pressure more than 1650Pa.

7 Measuring results of thermal performance testing
热性能测试结果

7.1 Pressure drop test 压力降测试

Serial no.序列号	20180704-8
Date 日期	2018-09-07
Tester 测试员	Jinping Yang

7.1.1 Test conditions 测试条件

Fluid used to pressurize collector 用于施加压力的流体	Water
Average fluid temperature [°C] 流体平均温度	19.6

7.1.2 Test results 测试结果

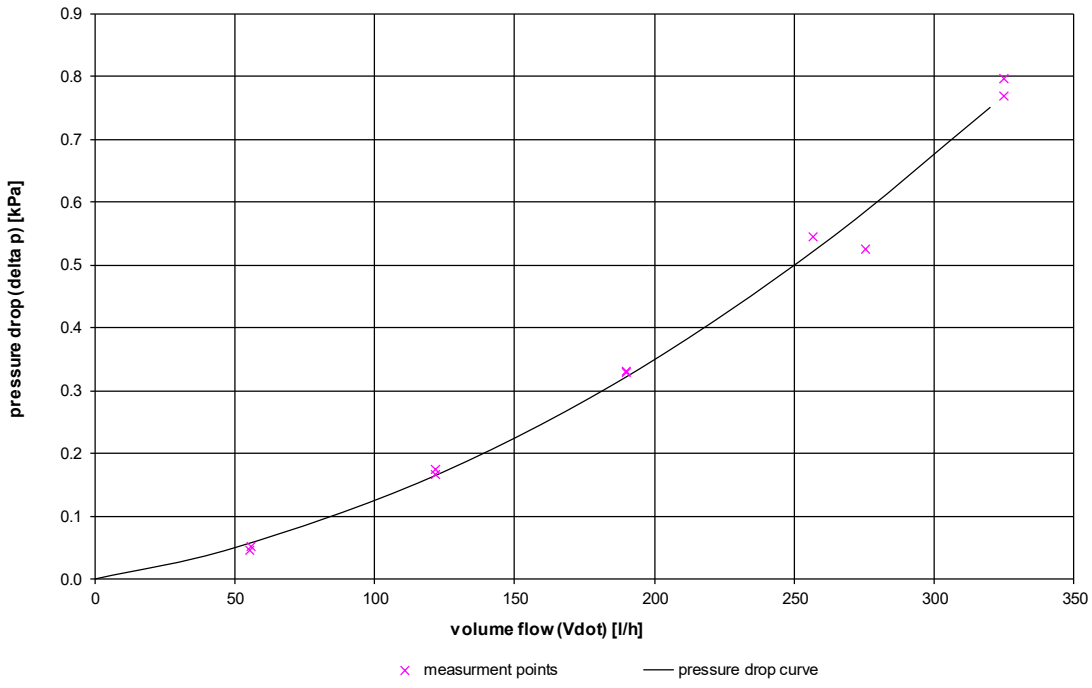


Figure 2: pressure drop curve 压力降曲线

Function of pressure drop curve 压力降曲线函数	$\Delta p(\dot{V}) = 5.013E\text{-}06*\dot{V}^2 + 7.434E\text{-}04*\dot{V}$

7.2 Test method according to ISO 9806:2017 chapter 23.3.4
根据 ISO 9806:2017 第 23.3.4 章的测试方法

Serial no.序列号	20180704-8	
Date (Start/End)开始/结束日期	2018-08-15	2018-09-05
Tester 测试员	Jinping Yang	

7.2.1 Test conditions 测试条件

Latitude [°]纬度	26°04' N
Longitude [°]经度	101°40' E
Collector tilt [° from horizontal] 集热器倾角（从水平面）	30 / 60
Collector azimuth [° from south] 集热器方位（从正南）	0
Orientation of absorber or pipes 吸热体/管道方位	Vertical See picture in Appendix 3: Photo documentation 参照附录 3：照片文件中的照片
Mass flow (A_G) [kg/(m²s)]质量流量	0.020
Gross area A_G [m²]总面积	3.001

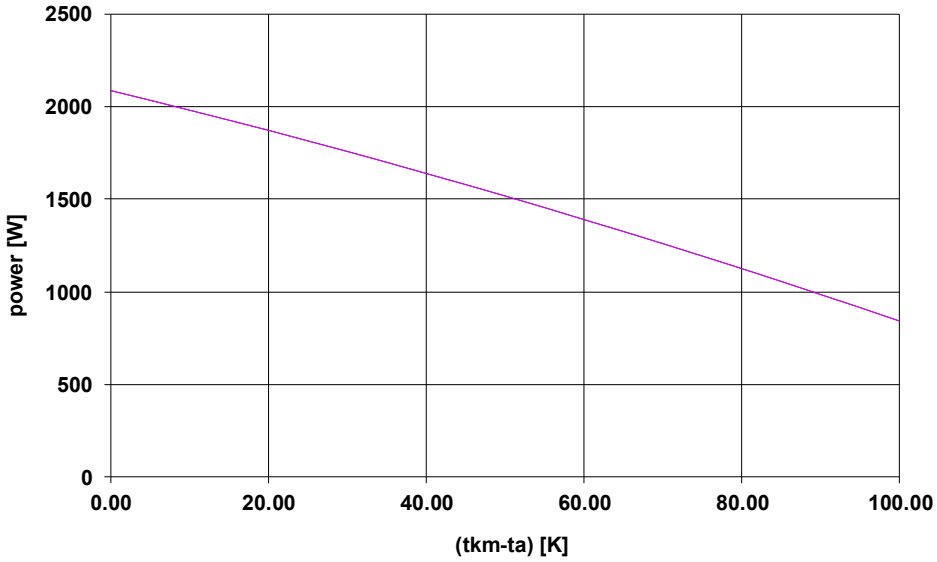
7.2.2 Test results thermal performance 热性能测试结果

Second order fit to data 二阶数据

$$\dot{Q} = A_G \left[\eta_{0,b} K_b(\theta_L, \theta_T) G_b + \eta_{0,b} K_d G_d - a_1 (\vartheta_m - \vartheta_a) - a_2 (\vartheta_m - \vartheta_a)^2 - a_3 u' (\vartheta_m - \vartheta_a) + a_4 \left(E_L - \sigma T_a^4\right) - a_5 (d\vartheta_m / dt) - a_6 u' G - a_7 u' \left(E_L - \sigma T_a^4\right) - a_8 (\vartheta_m - \vartheta_a)^4 \right]$$

Conversion factor η_{0a} [ ]热效系数	0.74 (based on gross area)基于总面积
Heat transfer coefficient a_{1a} [W/(m²K)] 热传导系数	3.645 (based on gross area)基于总面积
Temp. dependent heat transfer coefficient a_{2a} [W/(m²K²)]取决于温度的热传导系数	0.007 (based on gross area)基于总面积
Incidence angle modifier K_θ (40.2°/ 40.2°) [ ] 入射角修正系数	0.88
Effective heat capacity c [kJ/(m²K)]有效热容	11.919 (based on gross area)基于总面积
Time constant τ_c[s]时间常数	Not necessary for quasi-dynamic test method 对于动态法不需要此测试

Power curve *per collector unit (for G = 1000 W/m²)*
功率曲线 单一集热器单元（当 G = 1000 W/m²时）



Maximum power [W_{peak}] 最大功率 (G=1000 W/m²) per collector unit (G=1000 W/m²)时单一集热器单元	**2085.98**

Details of any damage and problems:任何损坏或问题的细节
No visual damages

For more details about thermal performance test see Appendix 1: Thermal performance test results 对于热效率测试的更多细节请参照附录 1：热性能测试结果

7.3 Collector incident angle modifier 集热器入射角修正

7.3.1 Test method according to ISO 9806:2017 Chapter 26
根据 ISO 9806:2017 第 26 章的测试方法

Serial no.序列号	20180704-8	
Date (Start/ End)开始/结束日期	2018-08-15	2018-09-05
Tester 测试员	Jinping Yang	

7.3.2 Test conditions 测试条件

Latitude [°]纬度	26°04' N
Longitude [°]经度	101°40' E
Collector tilt [° from horizontal] 集热器倾角（从水平面）	30 / 60
Collector azimuth [° from south] 集热器方位（从正南）	0
Orientation of absorber or pipes 吸热体或管道方位	Vertical See picture in Appendix 3: Photo documentation 参照附录 3：照片文件中的照片
Mass flow (A_G) [kg/(m²s)]质量流量	0.020
Gross area A_G [m²]总面积	3.001

7.3.3 Quasi-dynamic test results 准动态测试结果

Angle [°]	10	20	30	40	50	60	70
$K_{\theta b\ longi}$ () [ ]	1.00	0.99	0.97	0.93	0.88	0.78	0.58
$K_{\theta b\ trans}$ () [ ]							
Incidence angle modifier K_θ(50) [ ] **入射角修正系数**	**0.88**						

Requisite additional information for incident angle modifier:
入射角修正必须的附加信息：

The evaluation in Chapter 7.5 was detected according to ISO 9806:2017 Chapter 26
第 7.5 章的分析根据 ISO 9806:2017 的第 26 章进行.

For more details about incident angle modifier see Appendix 1: Thermal performance test results 入射角修正的更多细节请参照附录 1：热性能测试结果

8 General remarks 总论

All results only refer to the test samples that were subjected to testing. Symbols are in accordance with ISO 9488 and ISO 9806:2017 chapter 4. Solar Keymark – Specific Scheme Rules v31 March 2018 is not part of D-PL-11097-02-01 scope.

所有结果仅针对于经受过测试的样品.符号依据于ISO 9488 和 ISO 9806:2017 第4章.Solar keymark-特殊要求2018年3月v31版不在D-PL-11097-02-01范围内。

The extended total measuring uncertainty for the outdoor performance test based on gross area is: 基于总面积的室外性能测试测量扩展不确定度是：

U ≤ ± 2.35 % (for irradiation levels above 700 W/m² and K=2)

During outdoor tests irradiation class B “Temperate” according to ISO 9806:2017 was covered.
户外暴晒测试根据ISO 9806:2017中B级进行。.

Appendix 1: Thermal performance test results 热性能结果

Evaluation of quasi-dynamic collector test based on gross area and mean temperature of heat transfer fluid (multi linear regression/ simulation)

基于总面积和传热流体平均温度（多线性回归/模拟）的集热器动态法分析

Based on gross area:基于总面积	
Gross collector area used for curve: 用于曲线中的集热器总面积	3.001 m²
The quasi-dynamic collector model is defined by 动态集热器模型由以下公式定义	
$\dot{Q} = A_G \left[\eta_{0,b} K_b(\theta_L, \theta_T) G_b + \eta_{0,b} K_d G_d - a_1(\vartheta_m - \vartheta_a) - a_2(\vartheta_m - \vartheta_a)^2 - a_3 u'(\vartheta_m - \vartheta_a) + a_4\left(E_L - \sigma T_a^4\right) - a_5(d\vartheta_m/dt) - a_6 u' G - a_7 u'\left(E_L - \sigma T_a^4\right) - a_8(\vartheta_m - \vartheta_a)^4 \right]$	
Mass flow during test 在测试期间的质量流量 [kg/(m²s)]	0.020
Operating pressure during test [kPa] 测试期间的操作压力	150

Based on gross area 基于总面积

	Value	Unit
$F'(\tau\alpha)_{en}$	0.751	[ ]
$K_{\theta d}$	0.916	[ ]
$b_0(\theta)$	0.218	[ ]
c_1	3.645	[W/(m²K)]
c_2	0.007	[W/(m²K²)]
c_3	not determined 未定	[J/(m³K)]
c_4	not determined 未定	[W/(m²K)]
c_5	11.919	[kJ/(m²K)]
c_6	not determined 未定	[s/m]

Comparison between measurement and regression (see Figure A1.4):
测量值和回归值的对比

Total energy deviation [%]总能量偏差	-0.01
Objective [%]客观	1.98

The “objective” describes the ratio of the integrated absolute energy difference between measurement and simulation/ regression to the total measured energy during the complete test sequence.
“客观”描述了模拟值和测量值之间的综合绝对能量差/回归到完整测试顺序中的总测量能量.

Calculation of collector parameters 集热器参数的测量

Conversion factor η_0 热效系数	= $F'(\tau\alpha)_{en}$ $K_{\theta b}(\theta_{l,t}=15.0°)$ 0.85 + $F'(\tau\alpha)_{en}$ $K_{\theta d}(\theta)$ 0.15
Heat transfer coefficient a_1 热传导系数	= c1
Temperature dependent heat transfer coefficient a_2 随温度而变化的热传导系数	= c2
Effective heat capacity c 有效热容	= c5

Presentation of the used data set for regression 用于回归的数据情况

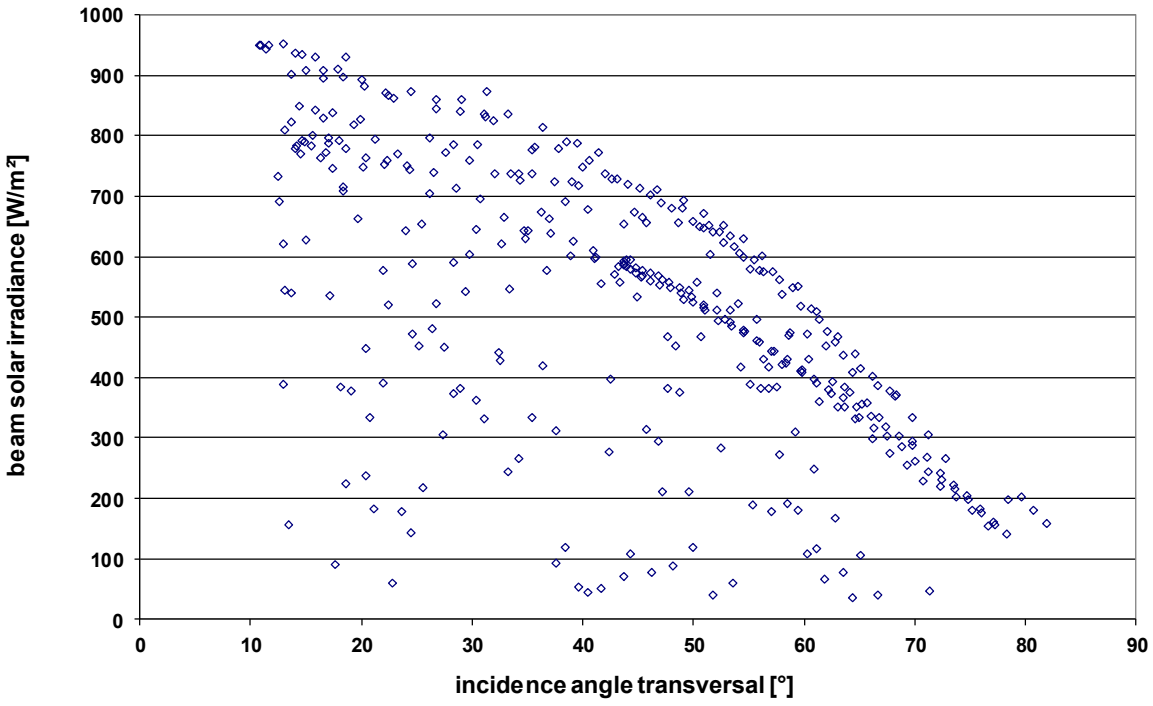


Figure A1.1: Direct solar irradiance over its incidence angle 直接太阳辐射与入射角关系

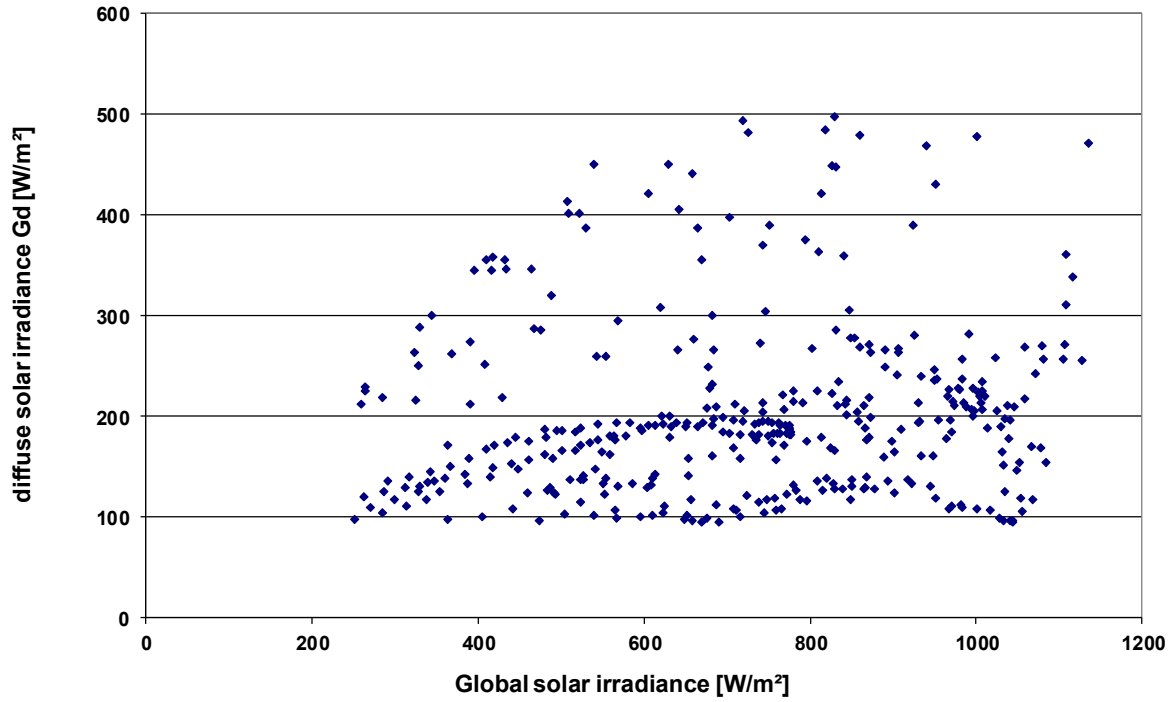


Figure A1.2: Diffuse solar irradiance over global irradiance 散射辐射与总太阳辐射的关系

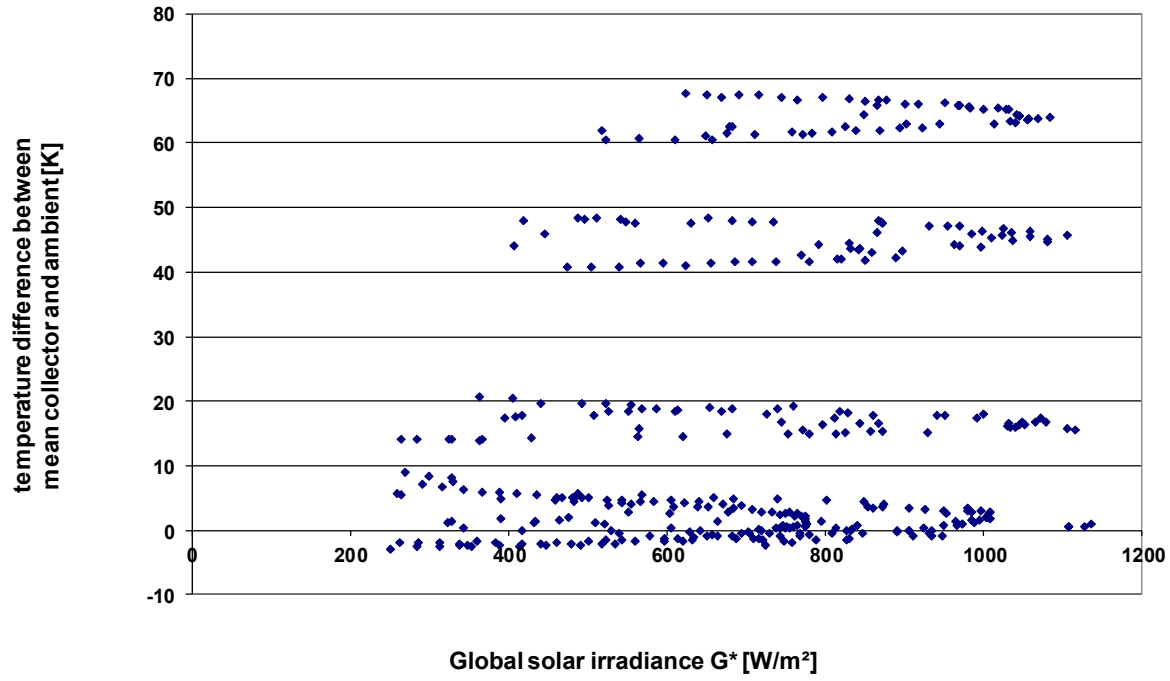


Figure A1.3: Temperature difference between mean collector and ambient temperature over global irradiance集热器平均温度和环境温度差值和总太阳辐射的关系

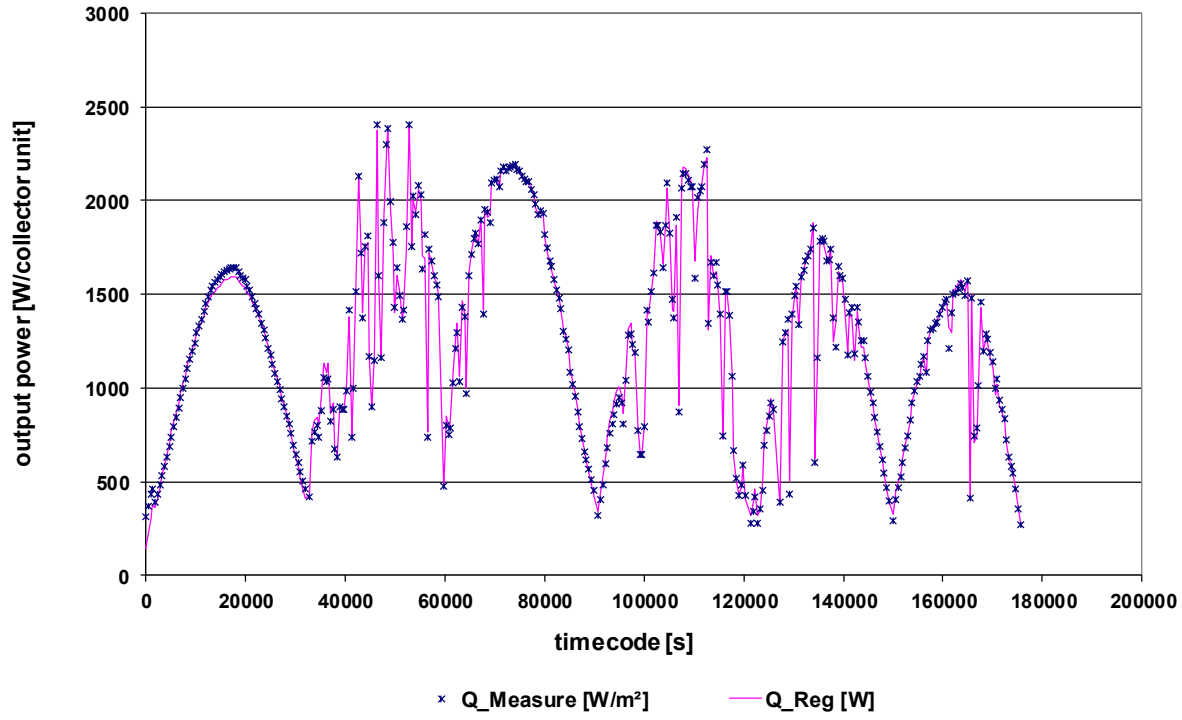


Figure A1.4: Measured and calculated power over time (full data set) 测量和计算功率和时间的关系（完整数据集）

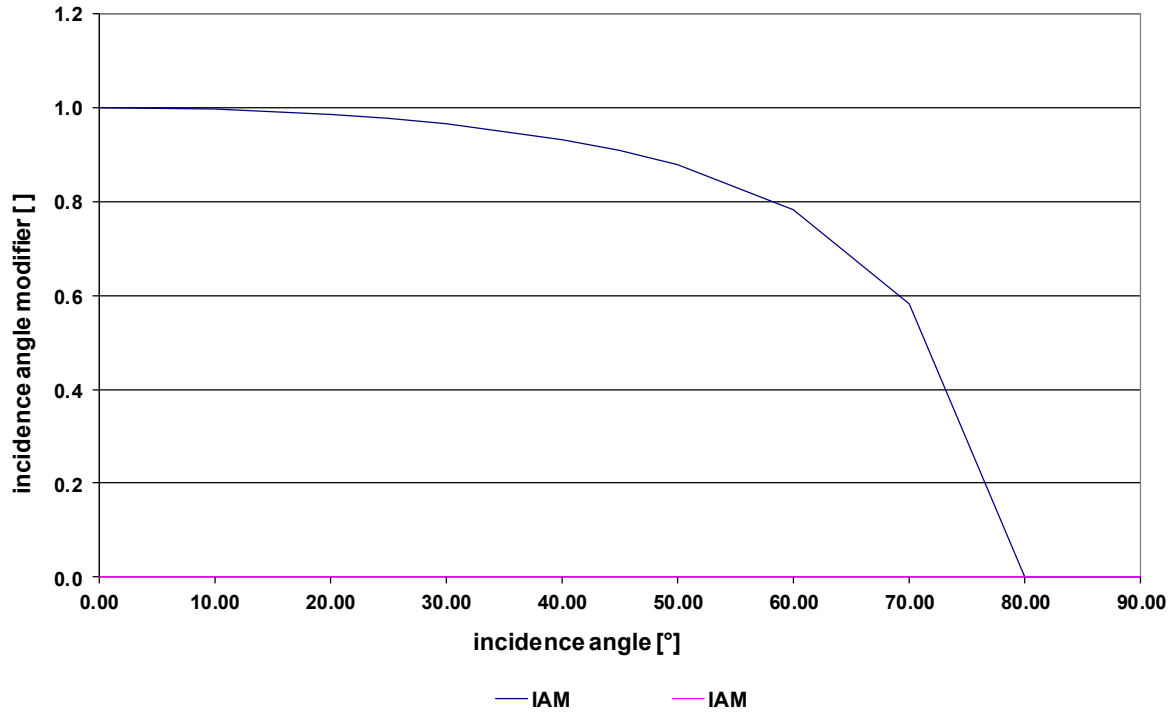


Figure A1.5: incidence angle modifier over incidence 入射角修正系数和入射角的关系

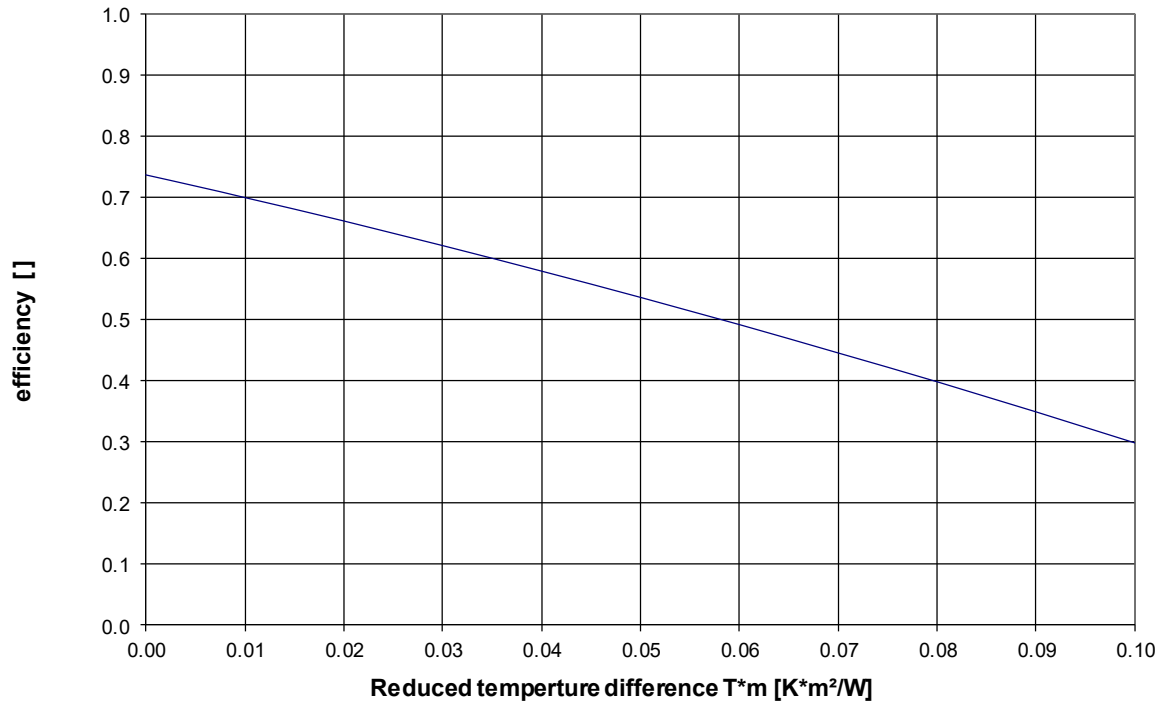


Figure A1.6: efficiency curve over reduced temperature difference at 1000W/m² irradiation 太阳辐射为1000W/m²时的效率和对比温度差曲线

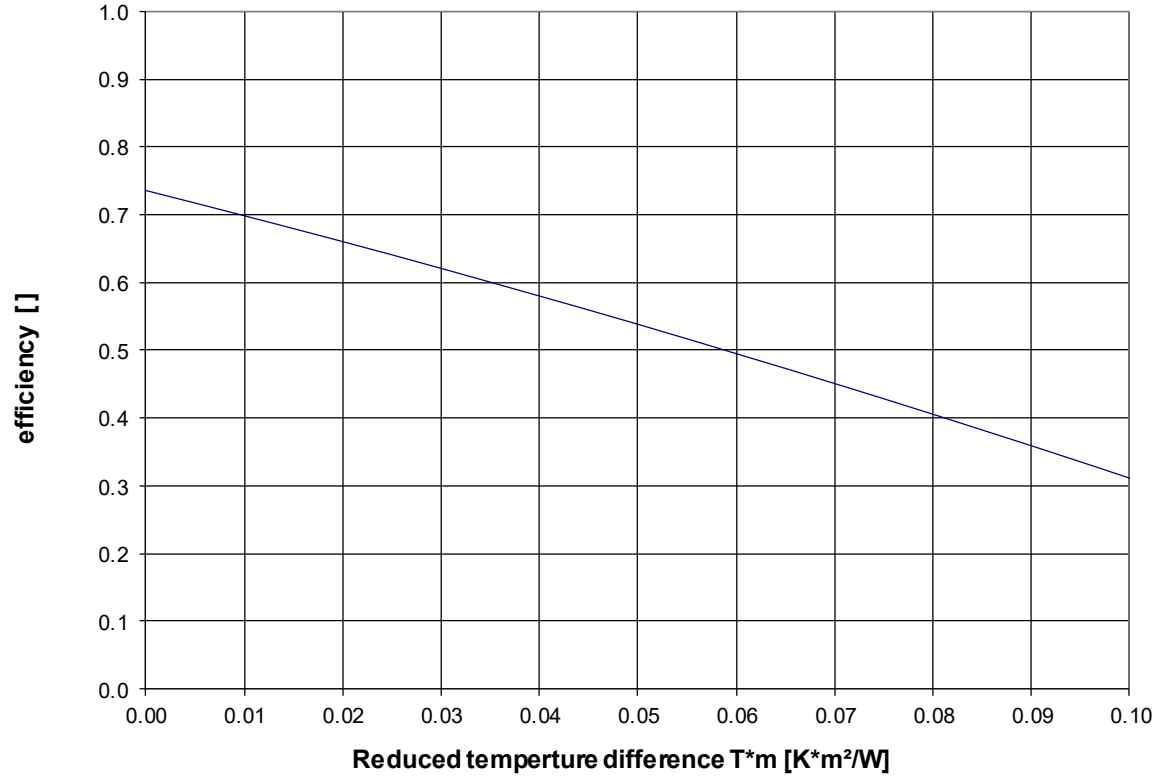


Figure A1.7: efficiency curve over reduced temperature difference at 800W/m² irradiation 太阳辐射为 800W/m²时的效率和对比温度差曲线

Appendix 2: Climate data 天气数据

August 18								
Date	time (G*>850W/m²)	ta (G*>850W/m²)	H	min ta	max. ta	mean ta	Rain	Comments
	min	°C	MJ	°C	°C	°C	l/m²	
2018-08-01	95	28.2	15.5	19.2	32.3	25.1	3.7	
2018-08-02	140	31.5	21.7	19.6	33.5	28.0	9.3	
2018-08-03			10.9	17.1	28.8	22.8	21.6	
2018-08-04			13.4	19.2	32.2	25.7	26.1	
2018-08-05			16.0	17.8	33.0	25.7		
2018-08-06	35	28.4	16.3	19.2	33.0	25.6	1.0	
2018-08-07			14.7	19.2	33.7	25.8	3.1	
2018-08-08			16.2	19.0	34.4	26.6	6.3	
2018-08-09	75	30.6	17.1	19.1	33.5	26.8	1.5	
2018-08-10	45	30.7	20.9	20.0	36.0	28.9		
2018-08-11			6.3	19.3	22.9	21.4	9.7	
2018-08-12	35	30.3	15.3	19.1	32.3	25.7	0.8	
2018-08-13	55	30.4	19.0	17.9	34.7	26.5	14.3	
2018-08-14	35	29.9	21.7	18.1	35.1	28.1	12.2	
2018-08-15	90	32.3	18.1	19.9	35.7	28.2	0.7	
2018-08-16	30	31.6	20.9	19.0	34.6	29.4		intermittent failure
2018-08-17			12.8	18.6	33.3	26.7		
2018-08-18			20.8	16.1	35.6	28.4		
2018-08-19	125	30.8	20.0	18.4	32.5	28.0	0.0	
2018-08-20			12.6	17.8	31.9	25.1		
2018-08-21	135	31.4	23.2	18.0	35.2	29.6		
2018-08-22	40	29.6	18.6	20.3	33.7	27.8		
2018-08-23	175	30.9	25.4	19.4	34.6	29.4		
2018-08-24	195	32.6	25.2	20.4	37.3	30.8		
2018-08-25	45	29.1	15.7	20.1	31.6	26.3		
2018-08-26			7.5	19.0	27.0	23.6		
2018-08-27	185	30.5	24.1	16.9	34.7	28.1		
2018-08-28	220	31.9	25.2	16.9	36.3	29.8		
2018-08-29	175	32.0	22.2	19.5	36.8	30.0	6.8	
2018-08-30	135	33.1	24.6	20.2	37.6	31.2		
2018-08-31	85	33.3	23.4	20.4	36.1	30.5		

September 18								
Date	time (G*>850W/m²)	ta (G*>850W/m²)	H	min ta	max. ta	mean ta	Rain	Comments
	min	°C	MJ	°C	°C	°C	l/m²	
2018-09-01	180	32.6	25.0	20.1	36.2	30.4		
2018-09-02	95	32.7	18.6	20.5	35.5	27.9	3.3	
2018-09-03			14.6	19.7	32.9	26.4		intermittent failure
2018-09-04	120	30.8	23.6	18.1	33.9	29.0		
2018-09-05	220	32.3	26.0	17.8	36.5	30.2		
2018-09-06	155	31.9	23.3	18.9	35.9	29.6		
2018-09-07			5.6	19.4	26.1	21.7	1.0	
2018-09-08			3.1	16.7	20.5	18.7		
2018-09-09			4.8	16.5	22.3	20.0	0.1	
2018-09-10	35	27.5	13.6	18.3	31.2	24.6		
2018-09-11			13.0	18.6	30.1	25.9		
2018-09-12			13.6	18.8	31.9	25.0	4.6	
2018-09-13	200	31.5	23.5	17.7	35.3	28.0		
2018-09-14	30	29.5	11.0	19.7	31.7	24.2	0.9	
2018-09-15	50	29.3	20.3	18.4	32.9	27.2		
2018-09-16	80	30.2	16.7	17.1	33.1	26.7		
2018-09-17	155	31.2	23.3	17.2	34.8	28.8	1.0	
2018-09-18			6.5	18.4	24.0	21.0	9.8	
2018-09-19	45	28.0	15.2	18.4	32.4	24.4	1.3	
2018-09-20			17.9	19.3	32.6	27.3		
2018-09-21	190	31.3	24.0	15.8	35.6	28.4		
2018-09-22			7.0	17.6	27.4	22.5	2.1	
2018-09-23			15.3	17.9	31.8	24.8		
2018-09-24	30	31.1	13.2	18.4	31.9	25.4		
2018-09-25								
2018-09-26								
2018-09-27								
2018-09-28								
2018-09-29								
2018-09-30								

Appendix 3: Photo documentation 照片文件

Fig. 2: incoming inspection
初检

Fig. 3: mechanical load test
机械荷载

Fig. 4: impact resistance test
耐冲击测试

Fig. 5: final inspection
终检

Fig. 6: final inspection
终检

Fig. 7: performance test
性能测试

Appendix 4: Measurement equipment list 测量设备清单

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Measurement Equipment List

Testing Start Date 02.08.2018
Testing end date 15.10.2018

Project Manager Cai Zhao
Cost Center 747
Test Report Number 50185939-001
Order Item Number 0154333482B00030

Customer Dezhou BTE Solar Co.,Ltd
Product Name BTE3.0-2
Comment

Old ID	Equip.	Description	Model	Manufacturer	Inte. (mon)	Due Date
PVST-005	1819501	Temperature sensor	WLS-3.0-1 Pt-1/10B	Roessel	12	04.05.2019
PVST-016	1819506	Hygro-Thermo transmitter	1.1005.54.701	Thies Clima	12	14.03.2019
PVST-027	1819512	Anemometer	4.3519.00.761	Thies Clima	12	05.01.2019
PVST-028	1819513	Anemometer	testo 425	testo	12	07.05.2019
PVST-031	1819515	Pressure gauge	2600T	ABB	12	08.01.2019
PVST-033	1819517	Pyranometer	CMP11	Kipp & Zonen	24	17.03.2019
PVST-036	1819518	Pyranometer	CMP21	Kipp & Zonen	24	02.05.2019
PVST-037	1819519	Pyranometer	CMP11	Kipp & Zonen	24	27.04.2020
PVST-038	1819520	Rainfall meter	5.4033.35.061	Thies Clima	24	16.05.2019
PVST-039	1819521	Balance	IS150IGG-H	Sartorius	12	18.10.2018
PVST-047	1819527	Digital multimeter	2701	Keithley	12	04.09.2018
PVST-049	1819529	Microcalliper	R600000003÷	XIBEI	36	13.03.2021
PVST-052	1819531	Steel ball	150g	NA	36	03.07.2021
PVST-055	1819534	Handheld thermometer	Testo 720	Testo	12	22.09.2018
PVST-056	1819535	Waterproof NTC immersion	0613 1212 (NTC)	Testo	12	22.09.2018
PVST-058	1819537	Pressure gauge	ConST 211	Const	12	13.03.2019
PVST-060	1819539	Multiplexer	7710	Keithley	12	04.09.2018
PVST-070	1819547	Multiplexer	7700	Keithley	12	04.09.2018
PVST-082	1819556	Pyranometer	CMP11	Kipp & Zonen	24	17.03.2019
PVST-085	1819559	Flow meter	DN4, FEP321-004	ABB	12	05.06.2019
PVST-107	1819564	Temperature sensor	WL-3,0-1PT-1/10B	Roessel	12	15.01.2019
PVST-111	1819567	Temperature sensor	WL-3,0-1PT-1/10B	Roessel	12	13.03.2019
PVST-151	1819597	Flow meter	VFS 1.3-20	Grundfoss	12	14.03.2019
PVST-167	1819608	Hygro-Thermo transmitter	1.1005.54.701	Thies Clima	12	14.03.2019
PVST-222	1819825	Signal transmitter	SI 010 CNV	Grundfoss	12	13.03.2019
PVST-224	1819827	Pressure gauge	RPS 0-10	Grundfoss	12	27.03.2019
PVST-226	1819829	Signal transmitter	SI 010 CNV	Grundfoss	12	14.03.2019
PVST-241	1819843	Temperature sensor	WL-3,0-1PT-1/10B	Roessel	12	13.03.2019
PVST-251	1819853	Temperature sensor	WL-3,0-1PT-1/10B	Roessel	12	13.03.2019
PVST-271	1819872	measuring tape	30-616	Stanley	36	30.12.2018

* No entry for devices that are not subject to regular gauging or calibration

Signature: Cai Zhao

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Measurement Equipment List

Testing Start Date	02.08.2018
Testing end date	15.10.2018
Project Manager	Cai Zhao
Cost Center	747
Test Report Number	50185939-001
Order Item Number	0154333482B00030
Customer	Dezhou BTE Solar Co.,Ltd
Product Name	BTE3.0-2
Comment	

Old ID	Equip.	Description	Model	Manufacturer	Inte. (mon)	Due Date
PVST-275	1819932	Vernier caliper	125MEA	Starrett	36	20.03.2021

* No entry for devices that are not subject to regular gauging or calibration

Signature: Cai Zhao