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

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: **154150039_Linuo_P-G-1.82_ISO_Report_chen**

Shanghai /上海, 2017-11-09

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Report-No.: 154150039_Linuo_P-G-1.82_ISO_Report_chen

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：	Linuo Ritter International Co., Ltd. No. 30766, EAST JINGSHI ROAD JINAN CITY, 250103 SHANDONG PROVINCE China
TÜV Quotation No. 报价编号：:	52150286
TÜV Order No.: 项目编号：	154150039
Order of: 立项日期：	2016-02-29
Date of Receipt of Test Item:样品接收日期：	2017-07-24
Commencement of Test:测试开始日期：	2017-07-25
TÜV Client No.:客户编号：	374961
Inspector:审核员:	Jinping Yang +86(0)878 6712707
Business Field:业务领域：	Solar/ Fuelcell Technology
No of Pages:页数：	20
Appendix:附件：	15 to 20

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

Manufacturer 生产商	Linuo Ritter International Co., Ltd.		
Brand 品牌	Linuo Ritter		
Collector type 集热器型号	P-G/0.8-T/L/LT-1.82		
Year of manufacture 生产年份	2017		
Length 长	2002 mm	Absorber area 吸收面积	1.85 m²
Width 宽	999 mm	Aperture area 采光面积	1.85 m²
Height 高	95 mm	Gross area 总面积	2.001 m²
Weight (empty) 空重	35 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	0.744	0.805	0.805
Heat transfer coefficient a_1	3.286 W/(m²K)	3.555 W/(m²K)	3.555 W/(m²K)
Temperature dependent heat transfer coefficient a_2	0.027W/(m²K²)	0.029 W/(m²K²)	0.029 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	524.47	971.19	1417.90
30	349.82	796.53	1243.25
50	132.03	578.75	1025.46

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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 : Linuo Ritter International Co., Ltd.
No. 30766, EAST JINGSHI ROAD
JINAN CITY, 250103
SHANDONG PROVINCE
China

Brand 品牌 : Linuo Ritter

Collector type 集热器型号 : P-G/0.8-T/L/LT-1.82

Test 测试项目	**Date** 日期		**Summary of main test results** 主要测试结果
	Start 开始	**End** 结束	
Thermal performance 热性能	2017-09-19	2017-10-15	No visual damages
Final inspection 终检	2017-11-03		No visual damages

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

Shanghai, 2017-11-9

Responsible for collector testing
测试负责人

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 should be performed with the aim of Solar Keymark certification.

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 测试基础

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 v30.00 April 2017: *"Specific CEN Keymark Scheme Rules for Solar Thermal Products"*

Solar Keymark -2017 年 4 月 v30.00 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	Linuo Ritter International Co., Ltd.
Brand name 品牌	Linuo Ritter
Collector Type 型号	P-G/0.8-T/L/LT-1.82
Category 类型	Covered flat plate
Date of manufacture 生产日期	2017
Serial number 序列号	20 068 443 010 013
Drawing numbers 图纸编号	PJF2-P2*1/*-*-261000

Collector & construction:

Gross dimensions l x w x t [mm] 总面积尺寸	2002 x 999 x 95①
Normative Absorber dimensions l x w [mm] x no. of fins 有效吸收面积尺寸	1951 x 949 x 1①
Physical Absorber dimensions l x w [mm] x no. of fins 额定吸收面积尺寸	1943 x 944 x 1①
Aperture dimensions l x w [mm] x no. glazes 采光面积	1951 x 949 x 1①
Gross/ Aperture/ Absorber area [m²] 总面积/采光面积/吸热体面积	2.00 /1.85 /1.85①
Weight empty [kg]空重	36.6①
Fluid content [l]流体含量	NA

Absorber:吸收体

Construction type 结构类型	Flat plate absorber②

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

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	0.4 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	0.058 ③

Absorber Piping:吸热体管路

Collector connection type / dimension / numbers 集热器接口/尺寸/数量	Pipe / 22mm / 4 ②
Header tube material / dimension 流道材料/尺寸	Copper / 22mm ①
Riser tube-header / tube-Absorber connection 流道集管/集管-吸热体连接	Brazed / brazed ②
Riser tube material / $Ø_{outer}$ / thickness / overall length [mm] 集管材质/直径/厚度/长度	Copper / 9.5 / 0.7 / 1875 ①
Number and Distance [mm] of riser tubes or fins on center position 集管数量以及间距	9 / 93 ①

Cover:玻璃盖板

Number of covers 数量	1	
Glazing to absorber space 玻璃盖板与吸热体间距	NA (measured on one point)	
	Glass 1	Glass 2
Length / width or $Ø_{outer}$ / thickness [mm] 长度/宽度（或者直径）/厚度	1976 / 976 / 3 ①	-
Material / surface and coating 材质/表明处理以及涂层	Glass / structured ②	-
Transmittance factor [ ] 透射比	0.9 ③	-

Casing: 边框（或者联箱）

Enclosure L x W x T [mm] 边框（或联箱）	2002 x 999 x 95 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

Enclosure material 材质	Aluminum alloy ②	
Enclosure backside material 背板材质	Zinc plate ②	
Frame fastening method 支架固定方式	Crimp connection ①	
Insulation 保温	Primary Material 第一层	Secondary Material 第二层
Material 材质	Glass wool ①	PUR ①
Thickness [mm]厚度	30 ①	16 ①
Material thermal conductivity [W/Km²] 材料导热系数	0.041 ③	0.041 ③
Lateral insulation 侧面保温	Primary Material 第一层	Secondary Material 第二层
Material 材质	Glass wool ①	-
Thickness [mm]厚度	NA	-
Material thermal conductivity [W/Km²] 材料导热系数	0.041 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	Silicon based ②

Limit values (given by manufacturer):限值（生产商指定）

Max. operating temperature [°C] 最大操作温度	99 ③
Maximum operating pressure [kPa] 最大操作压力	800 ③
Recommended Heat transfer medium 建议换热介质	Water glycol mixture ③
Recommended operating mass Flow [l/(m²h)] 建议流量	NA
Tilt angle limits [°] 倾角范围	25 to 60 ③
Collector mounting 安装	On roof / flat roof ③
Other limitations 其他限定值	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、最大和最小倾角时的压力降		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 厂家名称		Yes
Type of collector 集热器型号		Yes
Serial number 序列号		No
Year of manufacture 生产年份		Yes
Gross collector area 总面积		No
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		No
Durability:使用年限		No

6 Execution and evaluation 测试与评估

6.1 Visual inspection 外观检查

Date 日期	2017-07-25	Inspector 审查员	Jinping Yang
Internal barcode no. 内部编号	Serial no. 序列号	Description of defects 缺陷描述	
154150039-1	20 068 443 010 013	No visual damages	

Fig. 1: test sample label (random selection)
测试样品标签（随机抽样）

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

7.1 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	20 068 443 010 013	
Date (Start/End)开始/结束日期	2017-09-19	2017-10-15
Inspector 审查员	Jinping Yang	

7.1.1 Test conditions 测试条件

Latitude [°]纬度	26°04'
Longitude [°]经度	101°40'
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 2: 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	2.001

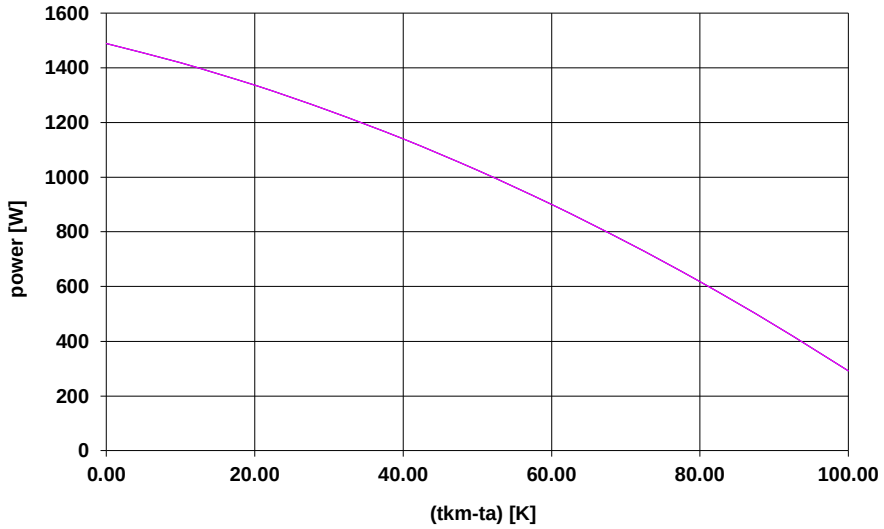
7.1.2 Test results thermal performance 热性能测试结果

Second order fit to data
二阶数据

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

Conversion factor η_{0a} [ ]热效系数	0.805 (based on aperture area)基于采光面积
Heat transfer coefficient a_{1a} [W/(m²K)] 热传导系数	3.555 (based on aperture area)基于采光面积
Temp. dependent heat transfer coefficient a_{2a} [W/(m²K²)]取决于温度的热传导系数	0.029 (based on aperture area)基于采光面积
Incidence angle modifier K_θ (40.2°/ 40.2°) [ ] 入射角修正系数	0.91 (based on aperture area)基于采光面积
Effective heat capacity c [kJ/(m²K)]有效热容	14.464 (based on aperture area)基于采光面积
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	**1489.05**

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

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

7.2.1 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	20 068 443 010 013	
Date (Start/ End)开始/结束日期	2017-09-19	2017-10-15
Inspector 审查员	Jinping Yang	

7.2.2 Test conditions 测试条件

Latitude [°]纬度	26°04'
Longitude [°]经度	101°40'
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 2: 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	2.001

7.2.3 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	0.95	0.91	0.83	0.68
$K_{\theta b\ trans}$ () [ ]							

Incidence angle modifier K_θ(50) [ ] **入射角修正系数**	**0.91** (based on aperture area)基于采光面积

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

The evaluation in Chapter 7.2 was detected according to ISO 9806:2017 Chapter 26.4
第 7.2 章的分析根据 ISO 9806:2017 的第 26.4 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.

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.

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：

$\eta_0 \leq \pm 3.2$ % (for irradiation levels above 700 W/m² and K=2)

To minimize back side reflectivity during thermal performance test, a black plastic film with low reflectivity (< 20%) was used!

为使热性能测试期间背部反射达到最小值，背部使用了黑色遮阴网使反射率小于 20%

During outdoor tests irradiation class C “Temperate” according to ISO 9806:2017 was covered.

户外暴晒测试根据ISO 9806:2017中C级进行。.

Appendix 1: Thermal performance test results 热性能测试结果

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

基于采光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 aperture area:基于采光面积		
Aperture collector area used for curve: 用于曲线中的集热器采光面积	1.850m²	
The quasi-dynamic collector model is defined by 被定义为动态集热器模型		
$Q/A_a = F'(\tau\alpha)_{en}\ K_{\theta b}(\theta)\ G_b + F'(\tau\alpha)_{en}\ K_{\theta d}(\theta)\ G_d - c_6 uG^* - c_1(t_m-t_a) - c_2(t_m-t_a)^2 - c_3 u(t_m-t_a) - c_4(E_L-\sigma T_a^4) - c_5 dt_m/dt$		
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 aperture area 基于采光面积		
	Value	Unit
$F'(\tau\alpha)_{en}$	0.816	[ ]
$K_{\theta d}$	0.942	[ ]
$b_0(\theta)$	0.169	[ ]
c_1	3.555	[W/(m²K)]
c_2	0.029	[W/(m²K²)]
c_3	not determined 未定	[J/(m³K)]
c_4	not determined 未定	[W/(m²K)]
c_5	14.464	[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	0.75
Objective [%]客观	3.93

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

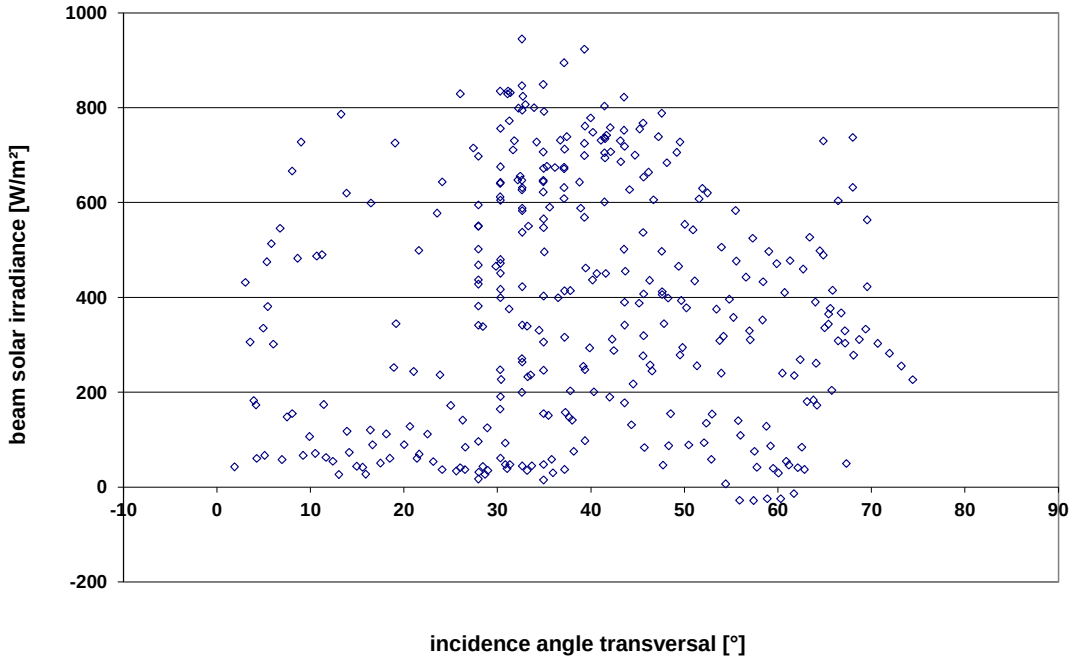


Figure A1.1: Direct solar irradiance over its incidence angle 直接太阳辐射与入射角关系

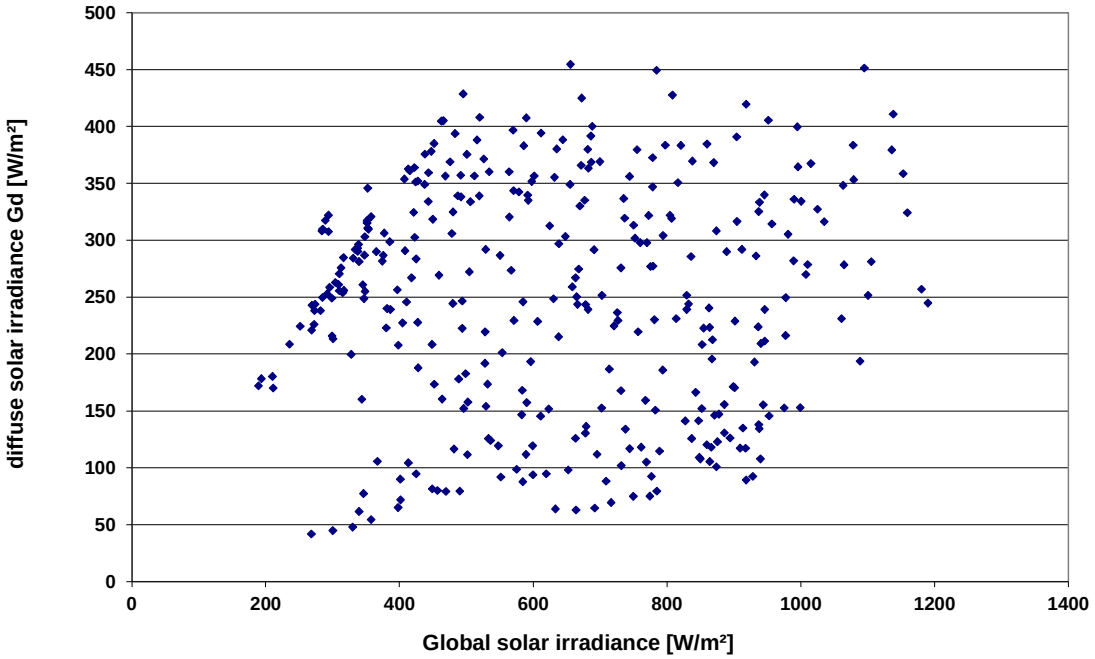


Figure A1.2: Diffuse solar irradiance over global irradiance 散射辐射与总太阳辐射的关系

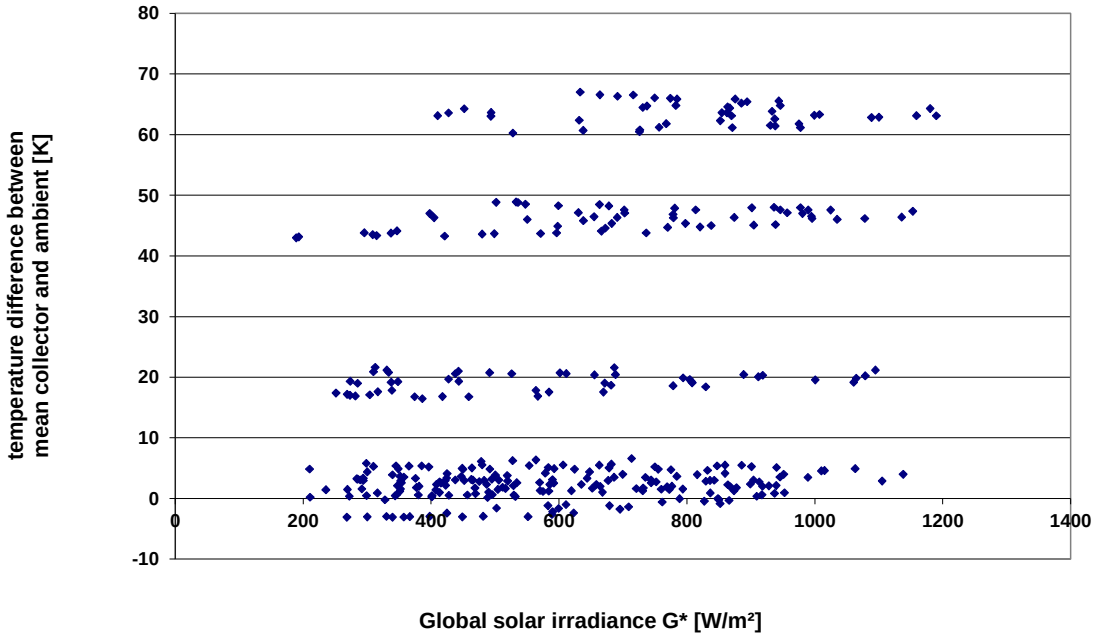


Figure A1.3: Temperature difference between mean collector and ambient temperature over global irradiance集热器平均温度和环境温度差值和总太阳辐射的关系

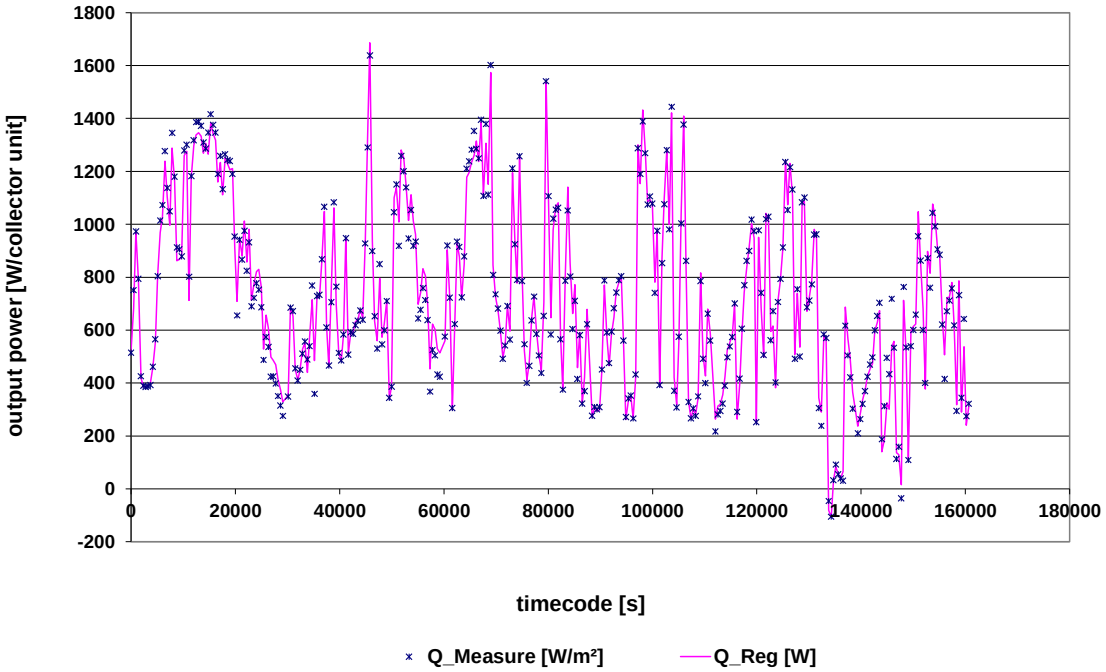


Figure A1.4: Measured and calculated power over time (full data set) 测量和计算功率和时间的关系（完整数据集）

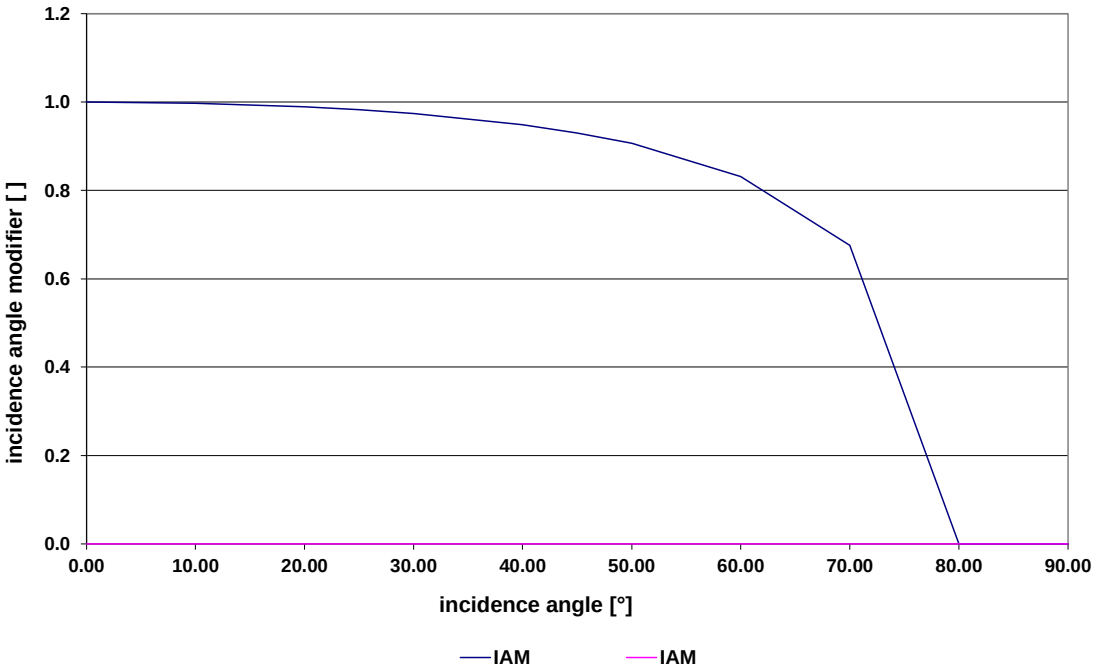


Figure A1.5: incidence angle modifier over incidence 入射角修正系数和入射角的关系

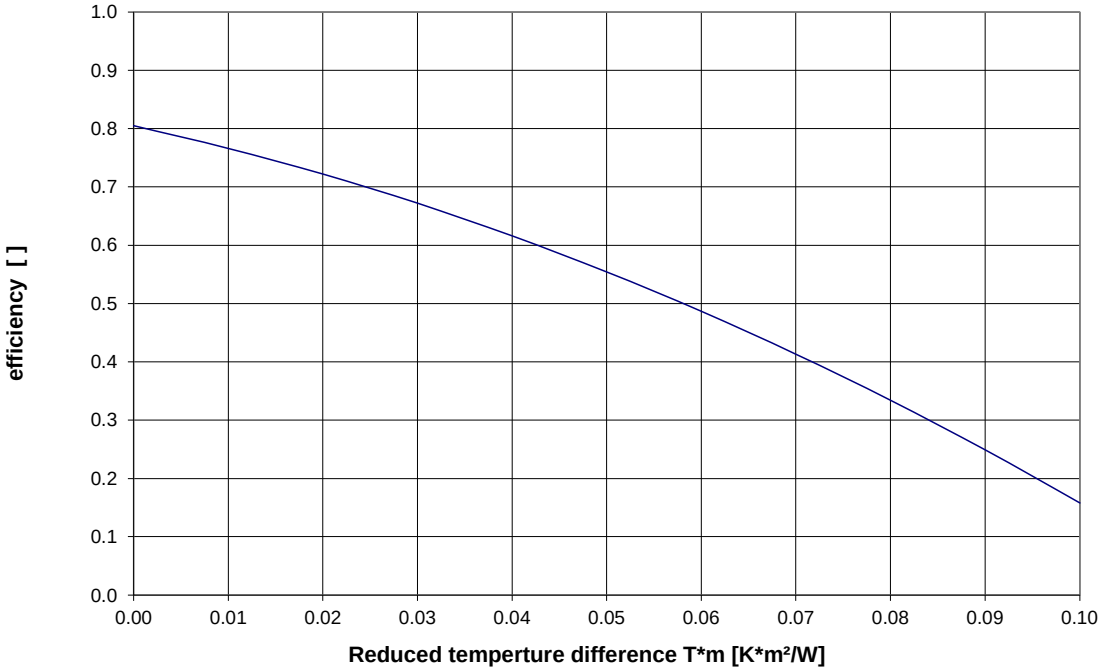


Figure A1.6: efficiency curve over reduced temperature difference at 1000W/m² irradiation 太阳辐射为1000W/m²时的效率和对比温度差曲线

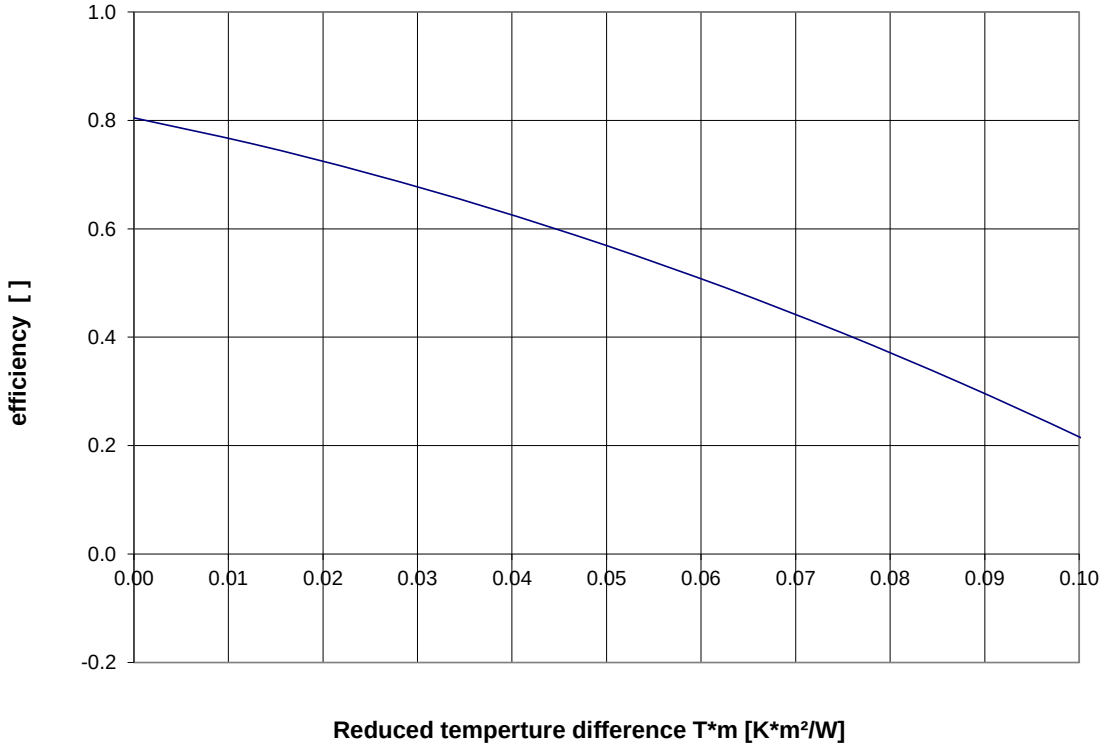


Figure A1.7: efficiency curve over reduced temperature difference at 800W/m² irradiation 太阳辐射为 800W/m²时的效率和对比温度差曲线

Appendix 2: Photo documentation 照片文件

Fig. 2: incoming inspection
图2：初检

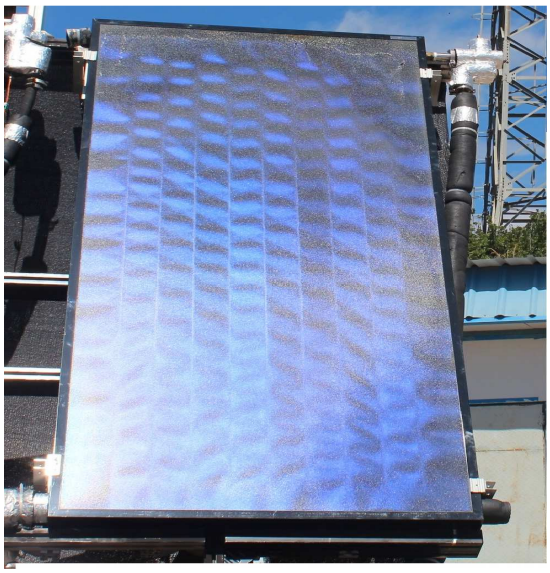


Fig. 3: performance test
图3：性能测试