Vocation Standards of the People's Republic of China

NY/T 219□2003

Focusing solar cooker

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Preface

Appendix A presents the referenced materials.

The standard was established by the Science and Education Department of Ministry of Agriculture.

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This is the first redaction since the first issue in 1992

Focusing solar cooker

1 Scope

Classifications, technical requirements, test method and regulation of focusing solar cookers are specified by the standard that suits the parabolic focusing solar cooker with horizontal pot ring and may be referenced by other focusing solar cookers.

2 Referenced Standards

Quoted by the standard, Terms originated from the following files become parts of the standard. Any quoted documents with dates, together with its successive redaction (corrected printing errors exclusive) are not suitable for the standard, but agreeing sides of this standard are encouraged to discuss whether to apply its latest versions. And the latest versions of quoted documents without marking dates are suitable for this standard.

GB 191 Markers of packaging, storage and transportation

GB/T 2705-1992 Classification, naming and types of coated products

GB/T 12467.1-12467.4-1998 Fusion welding of metal material required by welding quality

GB/T 13384 General technical requirements for packaging of electromechanical products

QB 1957-1994 Aluminum pots

3 Terms and definitions

3.1 Focusing solar cooker

Focusing solar cooker□abbreviated as solar cooker□, the set used for cooking by reflecting and accumulating direct beam radiant energy through paraboloid of revolution, is generally composed of cooker body, pot frame, pot ring, cooker frame and tracing device.

3.2 cooker body

Being a component of collecting and accumulating direct beam radiant energy, cooker body consists of cooker shell and reflecting material coated on the shell's surface.

3.3 Main ray axis

Main ray axis is the straight line connecting the cooker's origin and focus.

3.4 Utilized focal length

It is the distance between the centers of the pot ring and its projection's center on cooker body, when the main ray axis parallels with sun beam.

3.5 Intercept area

It is defined as the area that the cooker body project onto the plane perpendicular to direct beam radiation when solar cooker's main ray axis parallels with sun beam.

3.6 Operational height

It is the distance from the center of the pot ring to the ground when operating.

3.7 Operational distance

The Distance between pot ring center and rear brim of cooker body.

3.8 Range of utilized the beam radiation zenith angle

It's the available zenith angle for utilizing solar cooker.

3.9 Optical efficiency

Optical efficiency is the ratio of the energy absorbed by test pot and direct beam radiation projected onto the intercept area when heat loss equals to zero.

3.10 Rating power

This parameter is decided by the amount of energy collected by the test pot of solar cooker under the strength of solar beam radiation reaches 700W/m^2.

4. Specifications and Markers

4.1 Specifications

Specifications of solar cookers are grouped according to the size of the intercept area. The priority series and their corresponding focal lengths are shown in table 3.

Table 3. The priority series and their corresponding focal lengths of solar cooker

Intercept area (m^2)	1.0		1.2		1.6		2.0		2.5		3.2		4.0	
Focal length □mm□	500	550	550	600	600	650	700	750	750	800	850	900	950	1000

4.0 Markers

4.2.1 The markers of solar cooker are composed of two parts: technical characteristics and improvement serial numbers, written in capital Latin letters and Arabic figures.

4.2.2 Symbols and meanings of technical characteristics

4.2.2.1 The first letter 'P' expresses the paraboloid solar cooker

4.2.2.2 The material of cooker shell is showed by the second letter, generally using the first letter of the Chinese Pinyin alphabet of the material name, and when repeated or comes to letters such as I, O, X, the fist letter of the second character may be used.

Markers of common materials of the cooker shell are shown in table 1.

Table 1. Markers of common materials of the cooker shell.

Markers	B	G	H	L	M	S	T
Meaning	Glass Fiber	Steel Plate	Concrete	Aluminum	Compound of Magnesite	Plastic	Cast iron

4.2.2.3 The third letter expresses design features of the solar cooker, which is shown in table 2.

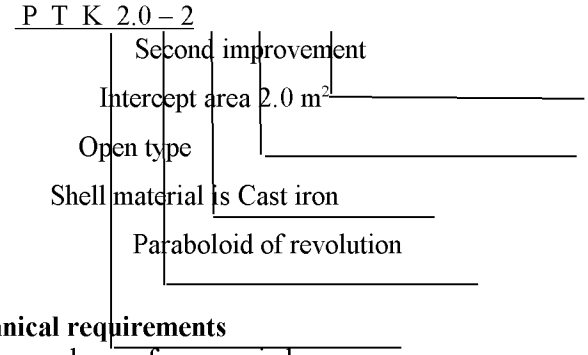
Table 2. Design features of the solar cooker

Markers	D	H	K	Z
meaning	Folding type	Box type	Open type	Automatic tracing type

4.2.2.4 The intercept area is expressed by Arabic figures and with one decimal after integer with unit of m^2.

4.2.3 Improvement serial number is shown by Arabic numbers in turn, which is divided by "-" from technical characteristic markers.

4.2.4 Example



5 Technical requirements

5.1 Solar cooker performance index

5.1.1 Optical efficiency should not be lower than 65□.

5.1.2 Rated power is no less than 455W/m^2.

5.1.3 The facula area at the center of the pot ring with the temperature over 400□should ranges from 50 cm^2 to 200 cm^2□shaped in roundness or oval.

5.2 Physical dimension

5.2.1 Maximal operational height should be no more than 1.25 m.

5.2.2 Maximal operational distance should not be greater than 0.80 m.

5.2.3 Solar cookers with intercept area of more than 2.5 m^2 are not limited by article 5.1.3, 5.2.1 and 5.2.2.

5.2.4 Minimal utilized zenith angle should not be less than 25°.

5.2.5 Maximal utilized altitude angle is no more than 70°.

5.2.6 Within the utilized scope of zenith angle, the angle between the pot ring and horizontal plane should not exceed 5°.

5.2.7 Tracing error of solar cooker with automatic tracing device is limited within ±2°.

5.3 Reflecting materials are required to have high specular reflectance (that of a aluminium coated film plating is no less than 0.80, while other materials no less than 0.72)□whose abradability and ageing resistance are good.

5.4 Cooker surface should be gloss, without any flaw or damage, and the reflecting material should be plastered well. Flexible reflective materials should not be wrinkled with less than 3 apophysises per m^2 with maximal area of 4cm^2; the space between two pieces of glasses is no wider than 1mm, and the grim is regular and without damage.

5.5 Welding parts should comply with the regulations of GB/T 12467.

5.6 The surface of oil paint should be gloss, uniform and honeymoon in tone with strong adhesion and aging resistance.

5.7 Cooker shell and its bearing frame should be well jointed in good inosculation.

5.8 The zenith angle and azimuth angle should be easy to adjust, accurate in tracing and reliable in stabilization.

6 Structure testing methods

6.1 Utilized focal length

Measure the distance between the centers of pot ring and its projection on cooker body by steel tape

or ruler, after adjusting solar cooker's main ray axis to parallel with sun beams.

6.2 Intercept area

When finishing adjusting the solar cooker and making its main ray axis with solar rays, the intercept area will be obtained by multiplying the total area of cooker body projected on the ground to the sine value of solar zenith angle.

6.3 Maximum operational height

The longest distance between pot ring center and the ground measured by steel tape or ruler when the pot ring is adjusted to the highest place.

6.4 Maximum operational distance

It refers to the distance from the center of pot ring to the cooker's rear edge after cooker's rear edge being adjusted to the longest horizontal distance to the pot ring.

6.5 Utilized zenith angle

6.5.1 Utilized zenith angle could be measured by protractor, and the measure errors should be limited within ±2°.

6.5.2 Minimum utilized angle is the angle formed by horizontal plane and the straight line linking both center points of cooker ring and its projection on the cooker body, when adjusting the cooker body forward until its limitation.

6.5.3 Maximum utilized angle is the angle formed by horizontal plane and the straight line linking both center points of cooker ring and its projection on the cooker body, when adjusting the cooker body back until its limitation.

6.6 Facular performance

6.6.1 Facular performance are measured by temperature testing board, a common plate with thickness of 0.5mm and 250mm in diameter, coated with nonluminous black lacquer on the nether side and 400□ temperature-sensitive paint on the upper side.

6.6.2 Procedure: After adjusting the solar beam to concentrate on the center of pot ring, put the temperature testing board on the pot ring immediately and take off it in 90s, observe the shape of light spot and work out the area over 400□.

6.7 Tracing device:

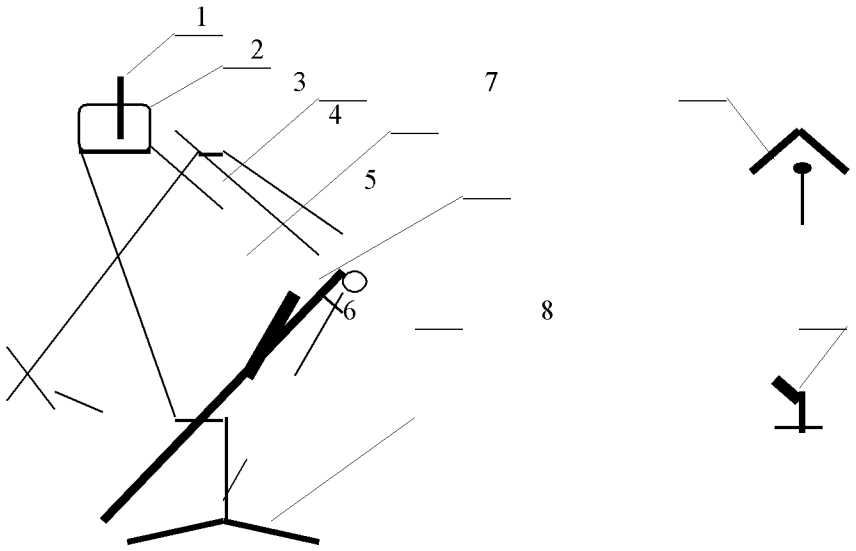
Put a 24cm aluminium pot with the water surface being 20mm from the pot brim; then adjust the tracing device and observing its stability and reliability within the solar cooker's utilizing scope.

7 Performance test methods

7.1 Test conditions

7.1.1 No shadow is allowed to be projected on the solar cooker during the test period, neither any energy from any other surfaces' reflection.

Test apparatus is shown in figure 1.



1. Thermometer 2. Test pan 3.Pan supports 4.cooker body 5.Tracing device
6. Base 7.Ambient temperature 8. Solar direct radiation meter

Figure 1. Solar cooker testing sketch map

7.1.2 During the testing period: the direct beam radiation should be no less than 600 W□m^2 with the fluctuation no more than 100 W□m^2.

7.1.3 During the testing period: keep the ambient temperature within 15□□35□, the wind velocity no more than 2 m□s.

7.1.4 During the testing period: solar zenith angle will be over 35°

7.2 Test instruments, meters and measurement

7.2.1 Direct beam radiation

7.2.1.1 Direct beam radiation and accumulative total radiant exposure can be measured using a radiation pyranometer together with a second order meter.

7.2.1.2 Radiation pyranometer must be calibrated according to the specification during its utilization course.

7.2.1.3 The time constant of radiation pyranometer should be less than 5s。

7.2.1.4 Instrumental error of radiation pyranometer should be no more than ±2□。

7.2.1.5 Errors of second order meter are to be no more than ±1□。

7.2.1.6 Tracy the radiation pyranometer manually every 5 min if it is without automatic tracing device.

7.2.2 Temperature

7.2.2.1 Temperature can be measured by mercury thermometer or thermoelectricity meter

7.2.2.2 Thermometer must be calibrated with Error limited in ±0.2□。

7.2.2.3 Thermometer should be put in slat box which is 1□1.5 m high over the ground, or in the equivalent condition, within 15m away from the solar cooker.

7.2.2.4 Thermometer should be immersed in the water in the pot and at the place where is the center of the pot and of 1/3 depth of the water to its bottom.

7.2.3 Wind velocity

7.2.3.1 Wind velocity could be measured by a spiral cup anemometer or a Auto Recored Electronic Wind Meter.

7.2.3.2 Anemometer Error should be limited within ±0.5 m□s.

7.2.3.3 Anemometer is placed at the same high as the pot and within 5m around the center of the solar cooker's frame.

7.2.4 Pot and water

7.2.4.1 The 24 cm diameter domestic aluminum pots (QB 1957□with its outer side of the pot bottom coted with black lacquer (Code 84) stated by GB/T 2705.

7.2.4.2 Water should be clean and transparent, and the test amount is 2kg per intercept area, while the maximum is not over 5kg.

7.2.4.3 The amount of water could be measured by platform balance, with the error within ±5g.

7.3 Test procedure and data processing

7.3.1 Test procedure

7.3.1.1 Aluminum pots are to be filled with water according to the article 7.2.4.2 and then thermometer are to be immerged into the water according to the article 7.2.2.4, recording the water temperature data whose initial value is 10□ lower than ambient temperature and ending value is 10±1□ higher than the ambient temperature.

7.3.1.2 Record the direct beam radiation and wind velocity every 2 minutes and adjust the manual tracing device every 5 min at least.

7.3.1.3 Record the time and accumulated radiant exposure when ending temperature of water reaches required number, and meanwhile, take the pot off, stirring the water by thermometer rapidly, record its temperature.

7.3.2 Data processing

7.3.2.1 Solar cooker's optical efficiency can be calculated with the following formula:

$$\eta_L = \frac{Mc(t_e - t_i)}{\quad} \qquad \text{……□1□}$$

HA_c

□□□ η_L——Solar cooker's optical efficiency□no dimension (□)□

M——Amount of the water, kg□

c——Specific heat of the water, kJ□(kg·□)□

t_e——Ending water temperature□ □□

t_i——Initial water temperature, □□

H—□Accumulated direct beam radiation, kJ□m^2□

A_c——Interception area, m^2.

7.3.2.2 Measurement should be repeated twice and use the average result as the solar cooker's optical efficiency, when relative error is less than 5□.

7.3.2.3 The rated power could be determined by putting the data obtained from 7.3.2.2 into following formula

$$P=700\eta_L A_c \qquad \text{……□2□}$$

P——Rated power of solar cooker, W.

8 Test regulations

8.1 The products can be sold after test and attaching with certification of qualification.

8.2 Production test is composed of ex factory test and Type test

8.2.1 Ex factory test refers to appearance test and adjustment test, and the results should comply with the requirements of articles from 5.4□5.8.

8.2.2 Type test consists of structure test and thermal performance test. The structure test follows the requirements of chapter 6, and the performance test complies with Chapter 7 and the results should accord with article 5.1 and article 5.2.

8.2.3 Productions should be under taken type test on the following situations□

a. Being put into production for the first time□

b. When the product performance are influenced by the change of design, technology or material.

C. Resuming manufacture after over one year idling period or changing the line of production□

d. asking overall inspect for products under regular production.

e. enquired by National Quality Supervision Institution.

8.2.4 Random sampling 2% of every batch ex factory products (not less than 2 sets each time); if any item is below grade, retesting should be made over double samples; and if there is still any item is not qualified, production must be stopped until some measures are taken and qualification is satisfied.

8.2.5 Formal test report of type test should be provided by testing organizations, and please refers to Appendix A for the form of the report.

9 Markers, packaging, storage

9.1 Markers

9.1.1 Clear, not easily removed markers should be put on the evident place of the solar cooker

9.1.2 Markers should be composed of the followings:

a. Manufacturer's name、Product's name、Trademark、Type□

b. Manufacture date and ex factory serial number□

c. Outline dimension□

d. Rated power.

9.2 Packaging

9.2.1 The container of solar cooker should accord with GB/T 13384, and its indication signs should comply with GB 191

9.2.2 Simple packaging is permitted under the guarantee of no damage of the products when making short distance transportation.

9.2.3 Following documents should be provided with the products:

a. Qualified certificate

b. Instruction of products

C. Packing list;

d. Spare reflecting materials for maintenance and method instruction□

e. Maintenance sheet。

9.3 Storage

Products should be stocked in dry and ventilated warehouse, keeping the cooker body upright to avoid distortion.

Appendix A

Example of Focus Solar Cooker Test Report

□Reference□

Focus Solar Cooker Test Report

Examinee_____ Type and Trademark_____

Manufacture date_____ Test date_____

1□Test Instruments and Meters

□1 Test instruments and meters

Name	Type	Precision	Examining Unit	Testing date

2□Pots

Diameter_____cm Material_____

3□Test Condition:

Site_____ Altitude_____m

Latitude_____° Longitude_____°

Scope of ambient temperature_____□

Scope of Wind velocity _____m/s

Scope of direct beam radiation_____W□m^2

4□Structure Test Results

Shell materials_____ Reflection materials_____

Utilized focus_____mm Intercept area_____m^2

Maximum operational height_____m

Maximum operational distance_____m

Area of facula spot_____cm^2 Shape of facula spot_____

Scope of utilized zenith angle_____°

Tracing method_____ Tracing state_____

Outline dimension_____m Weight_____kg

5□Performance Test Results

Table 2: Tested optical efficiency data

Name	Symbol	Unit	Test data	
			1	2
Amount of water	M	kg		
Average ambient temperature	t_a	□		
Initial temperature of water	t_i	□		
Ending temperature of water	t_e	□		
Average wind velocity	V	m/s		
Average rate of solar direct radiation	I_b	W□m^2		

Accumulated direct beam radiation	H	kJ☒m^2		
Start-stop time				
Optical efficiency	η_L	%		

Optical efficiency

η_L = %

Rated power

P= W

6☒Supplement and notes