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Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

Indian Standard
SOLAR FLAT PLATE COLLECTOR—SPECIFICATION
PART 3 MEASURING INSTRUMENTS
(First Revision)
AMENDMENT NO. 1 JUNE 2005
TO
IS 12933 (PART 3) : 2003 SOLAR FLAT PLATE COLLECTOR — SPECIFICATION
PART 3 MEASURING INSTRUMENTS
( First Revision )

(Page 1, clause 4.1, second sentence) — Substitute the following for the existing:

'For thermal performance test only, the instrument shall have the following minimum characteristics, which are consistent with or superior to those of a pyranometer according to IS 8336.'

(ME 04)

Reprography Unit, BIS, New Delhi, India
FOREWORD

This Indian Standard (Part 3) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-conventional Energy Sources Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was published in 1990. In this revision attempt has been made to align the measuring instruments requirements for measuring solar radiation, temperature liquid flow, pressure time, mass and wind velocity with those given in ISO 9060-1990 'Solar Energy — Specification and classification of instruments for measuring hemispherically solar and direct solar radiation' as far as possible.

In order to facilitate the reference and use, this standard is one of a series of solar flat plate collector standards. Other standards are as follows:

<table>
<thead>
<tr>
<th>IS No.</th>
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<tbody>
<tr>
<td>IS 12933</td>
<td>Solar flat plate collector — Specification:</td>
</tr>
<tr>
<td>(Part 1) : 2003 Requirements (second revision)</td>
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Part 4 of this standard which covered performance requirements and acceptance criteria for solar flat plate collectors was subsequently withdrawn and its contents incorporated in Part 1.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
1 SCOPE

1.1 This standard (Part 3) specifies the measuring instruments for solar flat plate collector for water heating.

1.2 This standard does not apply to the following:
   a) Collector in whom heat transfer fluid may change phase, that is, the collectors designed for normal fluid temperature above 100°C with water as the heat transfer fluid;
   b) Concentrating collectors, used in a system designed to generate mechanical energy/electricity;
   c) Collectors in which the thermal storage unit is an integral part of the collector so that the collection and the storage processes cannot be separated;
   d) Unglazed flat plate collector;
   e) Installation or mounting of solar collectors; and
   f) Tracking mechanism of the sun following collector system.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<table>
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<tr>
<th>IS No.</th>
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<tr>
<td>2806</td>
<td>Guide to electrical resistance thermometry (first revision)</td>
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<tr>
<td>3636</td>
<td>Method of test for temperature coefficient of precision resistor wires</td>
</tr>
<tr>
<td>8336</td>
<td>Thermoelectric pyranometer</td>
</tr>
<tr>
<td>12934</td>
<td>Solar energy — thermal applications — Vocabulary</td>
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3 TERMINOLOGY

For the purpose of this standard, the terminology and definitions given in IS 12934 shall apply.

4 MEASUREMENT OF SOLAR RADIATION

4.1 A pyranometer shall be used to carry out measurement of global short wave radiation from both the sun and the sky. The instrument shall have the following minimum characteristics, which are consistent with or superior to those of a first class pyranometer as classified in IS 8336, except where noted.

4.1.1 Change of Response Due to Variation in Ambient Temperature

The change in the instrument’s response due to variations in ambient temperature shall be less than ±1 percent during the test.

4.1.2 Variation in Spectral Response

Pyranometers shall have a constant sensitivity to within ±2 percent over the spectral range from 0.3 to 2.5 microns.

4.1.3 Non-linearity of Response

The response of the pyranometer in respect of linearity over the range of irradiance during the test shall be within ±1 percent. If it is more, then the pyranometer shall be used with a calibration curve in this respect.

4.1.4 Time Response

The time constant of the pyranometer, defined as the time required for the instrument to achieve a reading of 63.2 percent [that is (1-1/e)] of its final reading after a step change in solar irradiance, shall be less than 5 s.

4.1.5 Variation of Response with Angle of Incidence

Ideally, the response of the pyranometer is proportional to the cosine of the incident angle of the direct solar radiation and is constant at all azimuth angles. The deviation of the pyranometer reading for the incident angles encountered during the tests shall be less than ±1 percent from a true cosine response.

4.1.6 Variation of Response with Tilt

The variation in response of the pyranometer for tilts ranging from horizontal to the largest tilt encountered during the test shall not be greater than ±1 percent.
4.2 Precautions for Effects of Humidity and Moisture

The pyranometer shall be provided with means of preventing accumulation of moisture that may condense on surfaces within the instrument and affect its reading. An instrument with a desiccator that can be inspected is required. The condition of the desiccator shall be observed prior to and following each daily measurement sequence.

4.3 Precautions for Effects of Temperature Gradient

The pyranometer used during the test shall be placed in a typical test position and allowed to equilibrate for at least 30 min before data-taking commences.

4.4 Calibration of Pyranometer

The pyranometer shall be calibrated for solar response within 12 months preceding the collector test against other pyranometers whose calibration uncertainty relative to recognized measurement standards is known. Any change of more than ±1 percent over a year period shall warrant the use of more frequent calibration or replacement of the instrument. If the instrument is damaged in any significant manner, it shall be recalibrated or replaced.

4.5 Mounting of Pyranometer Outdoors

The pyranometer shall be mounted in such a manner that its sensor is co-planer with the plane of the collector aperture. It shall not cast a shadow onto the collector aperture at any time during the test period. The pyranometer shall be mounted at the mid-height of the collector so as to receive the same levels of solar radiation as are received by the collector.

5 TEMPERATURE MEASUREMENTS

5.1 Temperature measurements shall be made in accordance with IS 2806 and IS 3636.

5.2 Measurement of Inlet and Outlet Temperatures of the Heat Transfer Fluid

The accuracy of the instruments (including their associated readout devices) employed for measurement of inlet and outlet temperatures of the heat transfer fluid shall be ± 0.1°C. For ensuring that the temperature is not drifting with time, a resolution of the temperature signal better than ± 0.02°C is required.

5.2.1 Mounting of Sensors

The transducer shall be mounted at no more than 200 mm from the collector area and insulation shall be placed both upstream and downstream of the transducers. To ensure mixing of the fluid at the position of the temperature measurement, a bent in the pipe work, an orifice or a fluid mixing device shall be placed upstream of the transducer and the transducer probe shall point upstream as shown in Fig. 1.
5.2.2 Calibration of Sensors

The sensors used for measuring inlet and outlet temperatures of the heat transfer fluid shall be calibrated at least at yearly intervals.

5.3 Measurement of Ambient Air Temperature

The ambient air temperature shall be measured to an accuracy of ± 0.5°C. Adequate care shall be taken for mounting of sensor so as to ensure that it is shaded from direct and reflected solar radiation by means of a white painted, well ventilated shelter, such as meteorological screen, or by two concentric vertical metal pipes. The shelter itself shall be shaded and placed at the mid height of the collector but at least one metre above the ground surface to ensure that it is away from the influences of ground heating. The shelter shall be placed on one side of the solar collector and within 10 metres of it.

If air is forced over the collector by a wind generator, the air temperature shall be measured in the outlet of the wind generator and checks will be made to ensure that this temperature does not deviate from the surrounding air temperature by more than ± 1°C.

6 MEASUREMENT OF LIQUID FLOW RATE

6.1 The measurement accuracy of the liquid flow rate shall be equal to or better than ± 1 percent of the measured value in mass units per unit time.

6.2 The flow meter shall be calibrated over the range of fluid flow rates and temperatures to be used during collector testing at least annually.

7 MEASUREMENT OF WIND VELOCITY

7.1 The wind velocity over the front surface of the solar collector shall be measured with an instrument and associated readout device that can determine the integrated average wind velocity for each test period to an accuracy of ± 0.5 m/s.

7.2 As the surrounding air speed outdoors is seldom constant, an average air speed is obtained either by an arithmetic average of sample values or by a time integration over the test period.

7.3 The anemometer used for wind velocity measurement over the front surface of the collector shall be calibrated at regular intervals as per recommendations of manufacturer of the anemometer.

8 PRESSURE MEASUREMENTS

8.1 The inlet pressure to the collector shall be measured with a device having an accuracy of ± 3.5 kPa.

8.2 The pressure drop across the solar collector shall be measured with a manometer having an accuracy of 0.25 mm of water/liquid column.

9 INSTRUMENTATION/DATA RECORDERS

9.1 The smallest scale division of the instrument or instrument system shall not exceed two times the specified precision. For example, if the specified precision is ± 0.1°C, the smallest scale division shall not exceed 0.2°C.

9.2 Data Recorders

Analogue and digital recorders shall have an accuracy equal to or better than ± 0.5 percent of the full scale reading and have a time constant of one second or less. The peak signal indication shall be between 50 and 100 percent of full scale.

9.3 Integrators

Digital techniques and electronic integrators shall have an accuracy equal to or better than ± 1 percent of the measured value.

9.4 Input Impedance

The input impedance of the recorder shall be greater than 1 000 times the impedance of the sensors or 10 mega-ohms which ever is higher.

10 ELAPSED TIME

Elapsed time measurements shall be made to an accuracy of ± 0.2 percent.
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Amendments Issued Since Publication

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