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TECHNICAL SPECIFICATION

colour inside

Solar thermal electric plants – Part 3-3: Systems and components – General requirements and test methods for solar receivers

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FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62862-3-3, which is a Technical Specification, has been prepared by IEC technical committee 117: Solar thermal electric plants.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
117/104/DTS	117/107/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62862 series, published under the general title *Solar thermal electric plants*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The receiver is one of the most important and most sensitive components of Fresnel and parabolic trough power plants. Large mirrors are aligned to concentrate solar radiation up to 80 times along the focal line of the mirrors onto the specially coated, evacuated receivers. The generated heat is transported to a power generation unit, using a heat transfer fluid, and converted to electricity.

The quality and long-term performance stability of the receiver has a decisive influence on how effectively solar radiation can be converted into heat. For the power plant to achieve maximum efficiency, the receiver has to absorb as much solar radiation as possible and convert it into heat with minimized losses.

The solar receiver (see schematic in Figure 1) mainly consists of:

- a steel absorber tube: heat transfer fluid flows through the stainless-steel absorber tube. A high-quality absorber coating converts the solar radiation into heat and minimizes infrared heat loss at the same time;
- a glass cover tube: the cover is made from borosilicate glass and is coated with an antireflective film to increase solar transmittance;
- evacuated space (annulus) or filled with noble gas between absorber tube and glass cover tube: the vacuum between steel absorber and glass cover is essential to suppress gas heat convection;
- bellows: the bellows are necessary to compensate for different rates of heat expansion of the steel absorber and the glass cover. In contrast to the glass cover, the hot absorber expands considerably when operating.

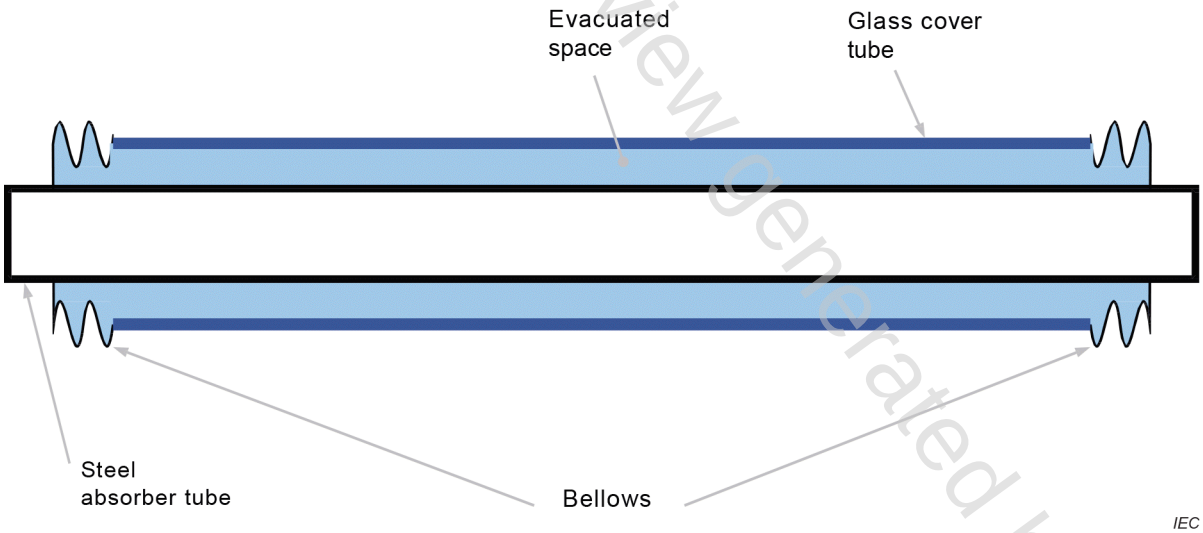

Figure 1 – Solar receiver schematic sketch

SOLAR THERMAL ELECTRIC PLANTS –

Part 3-3: Systems and components – General requirements and test methods for solar receivers

1 Scope

This document specifies the technical requirements, tests, durability and technical performance parameters of solar thermal receivers for absorbing concentrated solar radiation and transferring the heat to a fluid used in concentrated solar thermal power plants with linear-focus solar collectors. The receivers addressed consist of an absorber tube and an insulating glass envelope tube.

NOTE 1 Most of the test methods included in this document apply to solar receivers used both in solar thermal electric plants with parabolic-trough and Fresnel collectors.

This document includes the definitions of technical properties and characterization of geometry and performance parameters as well as the test methods for optical characterization, heat loss, and durability.

NOTE 2 The experience accumulated so far regarding the different test methods currently available for receiver tubes is not extensive enough to determine which test method is the best; this document describes all the different methods currently available without defining one recommended method.

For the sake of clarity, it is stated here that the thermal loss tests described in this document do not deliver the thermal loss of the receiver tubes when they are installed in commercial solar fields.

Thermal losses obtained by indoor testing on a single receiver are significantly lower than the thermal losses in outdoor, real operating conditions at commercial solar fields. However, the indoor test procedures described in this document are suitable for receiver tube performance comparison.

The thermal losses taken into account for solar field design are obtained by testing complete collectors operating under real solar conditions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 62862-1-1, *Solar thermal electric plants – Part 1-1: Terminology*

ISO 6270-2:2017, *Paints and varnishes – Determination of resistance to humidity – Part 2: Condensation (in-cabinet exposure with heated water reservoir)*

ISO 9806:2017, *Solar energy – Solar thermal collectors – Test methods*

ISO 9488:1999, *Solar energy – Vocabulary*

MIL-E-12397 – *Eraser, Rubber-Pumice (for testing coated optical elements)*

ASTM G173 – 03 – *Standard Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37° Tilted Surface*

3 Terms, definitions, symbols and units

For the purposes of this document, the terms, definitions, symbols and units contained in ISO 9488 and IEC 62862-1-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Performance test of the receiver

4.1 General

As receivers are one of the most important components in the solar field, they have a big impact on the performance of the entire solar field. In order to be able to best simulate the lifetime performance of the receiver as well as that of the solar field, it is crucial to perform tests that characterize the receiver and its performance.

4.2 Identification and geometry

The receiver usually has a brand name for the product and is also defined by the outer diameter of the stainless-steel tube. Another important identifier/parameter is the length of the receiver, which may vary depending on the trough for which it is designed. Additional parameters such as absorptance, emittance, transmittance, vacuum pressure, stainless-steel material, design temperature and pressure and the Heat Transfer Fluid for which it is designed, can be obtained from the manufacturer. These parameters/characteristics should be noted as part of the report for the receiver being tested.

4.3 Manufacturer's instructions

In addition to the parameters in 4.2, the manufacturer may have additional instructions for the use/preparation of the receiver or parts thereof for testing, for example, the cleaning of samples prior to carrying out optical measurements. These instructions shall be noted as part of the test procedure in case they have an effect on the results.

4.4 Calibration of testing instrumentation

Unless otherwise indicated by the manufacturer of the testing device, all instruments used should be calibrated at least once a year. In the event that a device is used that requires special calibration (i.e. spectrophotometer requiring calibration using a "golden sample"), this should be noted in the report including the date of calibration and the specimen used.

4.5 Heat loss test

4.5.1 General

NOTE In 2016, a round robin test was carried out within the European project STAGE-STE (European Union Seventh Framework Program FP7 (2007-2013) under grant agreement ID 609837) with five different tubes from different manufacturers. From this round robin, the heat loss testing results showed standard deviations in the order of 6 % to 12 % for most temperatures and receivers (see [1][1]).

[1] Numbers in square brackets refer to the Bibliography.