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Towards standard testing materials for high temperature solar receivers

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Abstract

Solar thermal technology for the production on electricity is one of the current technological challenges. In concentrating solar power (CSP) plants, in order to achieve high power it is required to use a high operating temperature to reach high conversion efficiencies. The majority of today's commercial solar thermal power plants are based on the parabolic trough collector technology with operating temperature around 400ºC. However, the technology of solar tower is used in order to maximize the efficiency of the CSP plants. This technology reaches an operating temperature higher than 1000 ºC and the development of high temperature receivers that work in this temperature ranges is still in its early stages. The fundamental problems observed are related to materials durability and reliability.

The main objective of this paper has been to develop testing methods for solar receivers which guarantee their reliability and durability under demanding working conditions of high solar concentrating technology. Based on a revision of published or draft Standards, a qualification test methodology for durability tests has been developed.

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Keywords: Solar tower; Receiver; Material durability

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1. Introduction

Due to the high investment costs of new component and material for solar thermal concentration technologies, investors are asking for guaranties for their power plant economical feasibility studies. But nowadays, there is no International Standard for component and material characterization and durability test methods due to the few solar tower power plant commercial experiences. The International committee for Standardization of CSP plants components, IEC TC 117, has just started to work on a testing standardization for solar plants and in particular for central tower plants.

One of the key aspects for solar power concentration materials is to determine the degradation during life-time under operating conditions through accelerated ageing test procedures. This analysis of testing methodologies for receiver is part of the Spanish project "MIRASOL" for fundamental research on materials for solar tower receiver. In this paper, different possible agents processes will be contemplated, and some possible testing methodologies will be defined.

Nomenclature

v	heating and cooling rate
t	time
t_{ac}	time accumulated
T	temperature
T_f	final temperature
T_i	initial temperature

2. Background

This paper gives a review of the state of the art of the possible accelerated ageing test that could be applied to receiver material candidates.

2.1. State-of the-art of Standard for solar thermal components

Relevant existing test methodologies from Standard have also been revised for solar components.
In Table 1 the tests performed to solar thermal collector for domestic hot water applications are summarized.

Table 1. Test methods for solar thermal collector

Standard	Test	Variables	Main instrumentation	Description
ISO 9806 [1]	High-temperature resistance	Absorber Temp. Global irradiance Ambient Temp. Wind speed	Temp. sensors Pyranometer Anemometer Data logger	Determination whether a collector can withstand high temperature and irradiance levels without failure and under non-operation conditions
ISO 9806 [1]	Exposure test	Global irradiance Ambient Temp. Rainfall	Pyranometer Temp. sensors Rain gage Data logger	Consists in exposing the collector until a minimum of days having passed a minimum irradiation and a minimum of hours to a minimum irradiance level.
ISO 9806 [1]	External thermal shock test	Global irradiance Ambient Temp. Water spray Temp. and flow rate	Pyranometer Temp. sensors Flowmeter Water spray device Data logger	Consists in exposing the collector having passed a minimum irradiance and then cooled by a water spray.