

Chapter 1

An Overview to Thermal Solar Systems for Low Temperature: Outlining the European Norm 12976

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ABSTRACT

This chapter deals with those prefabricated systems with a steady state of operation (state in which the temporal variation of the thermodynamic properties is null), describing, in a brief manner, a methodology for testing the characterization of the thermal performance in accordance with the European normative. All of the previously mentioned form the justification for a foundation or base from which a testing installation is proposed in a later chapter that, at the same time, is compared to a real installation. Lastly, this chapter attempts to outline a simple mathematical methodology to analyze the future behavior of the reliability of a system (solar in this case), when it is still in an extremely early stage of its life cycle, such as the design phase.

INTRODUCTION

Along the last decade, a great number of researches, master degree projects and doctoral thesis regarding diverse aspects of the application of solar energy, have been developed. In particular, some projects set out installations and methodologies that represent an important support in the search for solutions to technical problems in the field of solar thermal energy of low temperatures. These form the base from which this research is developed.

Some of these projects and theses do not contemplate the European Standard EN-12976 (parts 1 and 2) for thermal solar energy systems (norm that has been implemented nationally in Spain since June 2001). This norm deals with thermal solar energy systems and their components. In particular, it deals with prefabricated systems for the production of sanitary hot water through solar energy. The first part

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(EN-12976-1, 2006) specifies the general durability, reliability and safety requirements for thermal solar energy systems of prefabricated heating as products. The installation of these systems is not considered in this regulation, but it does include all requirements in the documentation for the person performing the installation and for the final user. In other respects, the second part of this norm (EN-12976-2, 2006) expresses the distinct testing methods applied to domestic solar energy systems for the validation of the prior requirements.

The European Standard “Thermal solar systems and components” has been prepared by the European Committee for Normalization, with the aim to normalize and homogenize at a European level all diverse norms that have previously existed in each E.U country. Therefore, this normative is directly applicable to each member state and its interpretation (as well as possible omissions in the text) should have global and supranational aspirations. In short, the work developed in this book is intended to be applied as an example for emerging countries, following the next objectives:

- Analyzing the European normative regarding thermal solar energy systems prefabricated with a steady regime of performance.
- Adapting a real testing installation to this new normative.
- Describing an analytical procedure to forecast the reliability behavior of a thermal solar energy system.

BASIC CONCEPTS ON THE SOLAR ENERGY UTILIZATION

This section includes a series of concepts related to solar energy that will facilitate the understanding of the whole book. These concepts are extracted from the applicable European normative for that purpose, EN ISO 9488 “Solar energy. Vocabulary”.

The main terminology regarding to radiation and outside conditions are as follows:

- **Radiation:** The emission or transfer of energy in the form of electromagnetic wave or particles.
- **Irradiance (G):** The radiant power incident on a unit area of a given surface. It is expressed in W / m^2 .
- **Irradiation (H):** The energy incident on a unit area of a given surface, resulting from the integration of the irradiance during a given time interval, normally an hour or one day. It is expressed in MJ / m^2 , for the specified time interval.
- **Direct Solar Radiation:** The solar radiation incident on a given surface, coming from a small solid angle centered in the solar disc. Direct radiation is measured generally under normal incidence.
- **Hemispherical Solar Radiation:** The solar radiation incident on a given flat surface, received from a solid angle of 2π sr (of the hemisphere located above the surface). It is composed of direct and diffuse solar radiation.
- **Global Solar Radiation:** The hemispherical solar radiation received from a horizontal surface.
- **Diffuse Solar Radiation:** The hemispherical solar radiation minus the direct solar radiation. In solar energy technology, diffuse radiation includes the solar radiation dispersed in the atmosphere, as well as the solar radiation reflected by the ground, depending on the receiver surface inclination.
- **Solar Constant (I0):** The extraterrestrial solar irradiation¹, incident on a surface perpendicular to this radiation, when the Earth is located at a mean distance from the Sun ($149,5 \times 10^6$ km).

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