INTERNATIONAL STANDARD

ISO 9459-4

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Solar heating — Domestic water heating systems —

Part 4: System performance characterization by means of component tests and computer simulation

Chauffage solaire — Systèmes de chauffage de l'eau sanitaire —

Partie 4: Caractérisation de la performance des systèmes au moyen d'essais effectués sur les composants et par simulation sur ordinateur

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9459-4 was prepared by Technical Committee ISO/TC 180, *Solar energy*, Subcommittee SC 4, *Systems — Thermal performance, reliability and durability*.

ISO 9459 consists of the following parts, under the general title *Solar heating — Domestic water heating systems*:

— *Part 1: Performance rating procedure using indoor test methods*

— *Part 2: Outdoor test methods for system performance characterization and yearly performance prediction of solar-only systems*

— *Part 4: System performance characterization by means of component tests and computer simulation*

— *Part 5: System performance characterization by means of whole-system tests and computer simulation*

0 Introduction

ISO 9459 has been developed to help facilitate the international comparison of solar domestic water heating systems. Because a generalized performance model which is applicable to all systems has not yet been developed, it has not been possible to obtain an international consensus for one test method and one standard set of test conditions. It has therefore been decided to promulgate the currently available simple test methods while work continues to finalize the more broadly applicable procedures. The advantage of this approach is that each part can proceed on its own.

0.1 General

ISO 9459 is divided into four parts within three broad categories, as described below.

0.2 Rating test

ISO 9459-1, *Solar heating — Domestic water heating systems — Part 1: Performance rating procedure using indoor test methods*, involves testing for periods of one day for a standardized set of reference conditions. The results, therefore, allow systems to be compared under identical solar, ambient and load conditions.

0.3 Black box correlation procedures

ISO 9459-2, *Solar heating — Domestic water heating systems — Part 2: Outdoor test methods for system performance characterization and yearly performance prediction of solar-only systems*, is applicable to solar-only systems and solar-preheat systems. The performance test for solar-only systems is a “black box” procedure which produces a family of “input-output” characteristics for a system. The test results may be used directly with daily mean values of local solar irradiation, ambient air temperature and cold water temperature data to predict annual system performance.

0.4 Testing and computer simulation

ISO 9459-4, *Solar heating — Domestic water heating systems — Part 4: System performance characterization by means of component tests and computer simulation*, a procedure for characterizing annual system performance, uses measured component characteristics in a computer simulation program. Procedures for characterizing the performance of system components other than collectors are also presented in this part of ISO 9459. Procedures for characterizing the performance of collectors are given in other International Standards.

ISO 9459-5, *Solar heating — Domestic water heating systems — Part 5: System performance characterization by means of whole-system tests and computer simulation*, presents a procedure for dynamic testing of complete systems to determine system parameters for use in the “Dynamic System Testing Program”. This software has been validated on a range of systems; however, it is a proprietary product and cannot be modified by the user. Implementation of the software requires training from a test facility experienced with the application of the product. This model may be used with hourly values of local solar irradiation, ambient air temperature and cold water temperature data to predict annual system performance.

The procedures defined in ISO 9459-2, ISO 9459-4 and ISO 9459-5 for predicting yearly performance allow the output of a system to be determined for a range of climatic conditions.

The results of tests performed in accordance with ISO 9459-1 provide a rating for a standard day.

The results of tests performed in accordance with ISO 9459-2 permit performance predictions for a range of system loads and operating conditions, but only for an evening draw-off.

0.5 Introduction to ISO 9459-4

ISO 9549-4 presents a procedure predicting the annual performance of a solar thermal system using a numerical simulation programme. The parameters of the characterisation of the thermal behaviour of the key components such as solar collector, store and controller are derived from physical tests of the components.

Because testing of the complete system as a whole is especially expensive and time consuming for system families, this approach offers the opportunity to determine the annual performance of a family of systems with limited effort.

NOTE A system family is characterised by a series of hot water systems that are identical with regard to their construction and only differ in their collector and storage dimension. An identical construction is given if the set-up of the system is similar (pipes, electrical pump, hydraulic connections, type but not mandatorily size of the heat exchanger), the insulation concept is similar (material, thickness) and the collectors installed are from the same type.

Procedures exist for testing most solar thermal system components. Where they exist, they are referenced. In case no standardised component test procedures are available appropriate procedures have to be used to determine the thermal characteristics of the components.

The intention of this International Standard is to determine the thermal performance of the system. Therefore, it is assumed that all key components (e.g., collectors, stores, heat exchangers, etc.) used in the system are subjected to relevant durability tests (e.g., collector qualification tests, pressurization of the collector side of the heat exchanger, etc.) before they are tested for thermal performance.

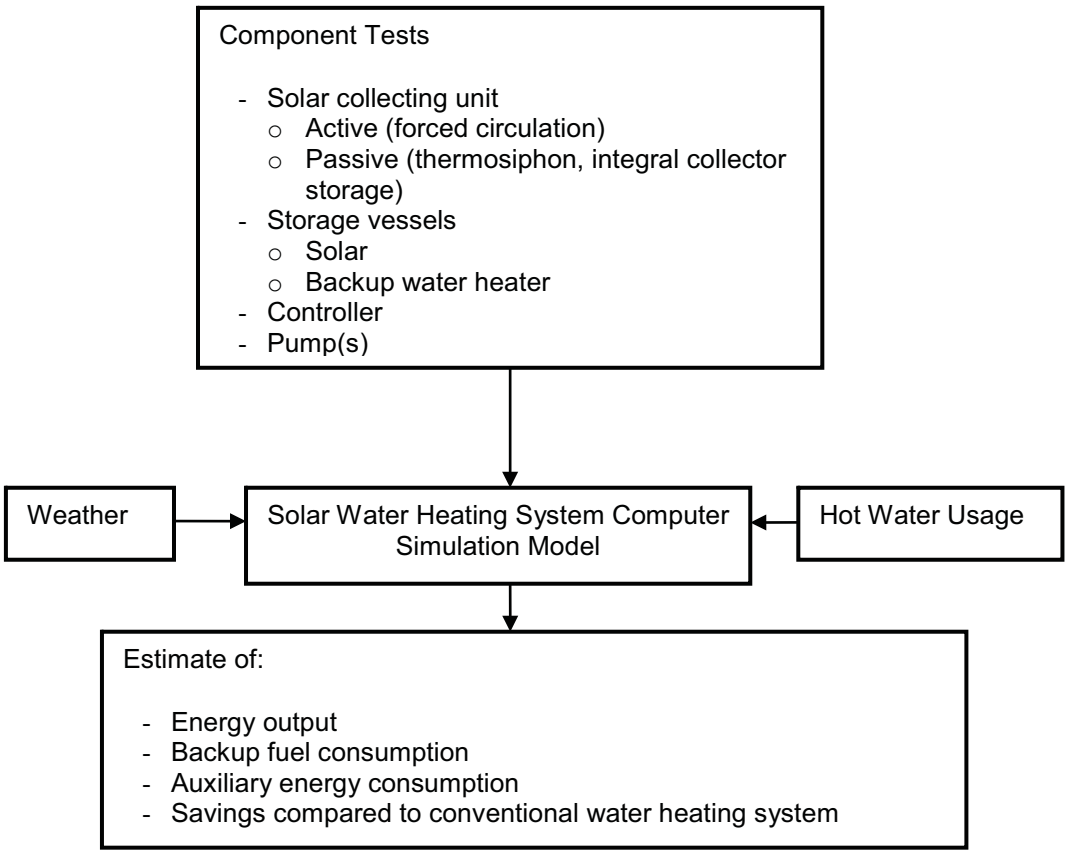
In order to ensure a proper operation of the entire system additional durability tests may be required of the complete system to determine operation under extreme conditions such as freezing or overheating based on corresponding standards.

The performance evaluation procedure defined in this International Standard has been designed to provide a means of evaluating the annual task performance of heated water systems.

This International Standard sets out a method of evaluating the annual energy performance of heated water systems using a combination of test results for component performance and a mathematical model to determine an annual load cycle task performance. This International Standard defines a procedure for evaluating the task performance of conventional electric and gas domestic water heaters so that the energy savings of solar and heat pump water heaters can be evaluated relative to conventional water heaters operated under the same annual task load.

The performance evaluations are based on modelling annual performance in a range of climatic conditions using a simulation program. The chosen simulation program shall have flexibility and the capacity to model the wide range of renewable energy water heaters used worldwide.

The procedure for using this International Standard is illustrated in the figure below. The general concept is to develop computer models that describe the performance of every component of the solar water heating system. These models can be based on specific tests (listed herein and in EN 12977-2 and AS/NZS 4234). These models are then combined in a system simulation that can be used to estimate the performance of the complete solar heating system under specified hot water usage and weather conditions. Information for users of this International Standard is presented in Annexes I and J.



It is the intent of this part of ISO 9459 to be compatible with EN 12977-2, “Thermal solar systems and components, Custom built systems, Test methods” such that tests conducted for use by certification bodies can be done in accordance with either one interchangeably.

The terms “normative” and “informative” have been used in this International Standard to define the application of the annex to which they apply. A “normative” annex is an integral part of an International Standard, whereas an “informative” annex is only for information and guidance.