ANSI/ASHRAE Standard 93-2003

ASHRAE® STANDARD

Methods of Testing to Determine the Thermal Performance of Solar Collectors

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Approved American National Standard

ANSI

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.

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Methods of Testing to Determine the Thermal Performance of Solar Collectors

(This foreword is not part of this standard but is included for information only.)

FOREWORD

This standard is a reaffirmation of ANSI/ASHRAE Standard 93-1986, but because the ANSI approval for the 1986 version of the standard expired in 2001, the current reaffirmed standard has been approved by ANSI as a "new" standard.

The standard provides a test procedure whereby solar energy collectors can be tested both indoors and outdoors to rate the collectors in accordance with their thermal performance and to determine their time constant and the variation of their efficiency with changes in the angle of incidence between the sun's direct rays and the normal to the collector aperture. This standard carefully defines its applicability to both liquid-cooled nonconcentrating and concentrating collectors and collectors that use air as the heat transfer fluid.

1. PURPOSE

The purpose of this standard is to provide test methods for determining the thermal performance of solar energy collectors that use single-phase fluids and have no significant internal energy storage.

2. SCOPE

2.1 This standard applies to nonconcentrating and concentrating solar collectors in which a fluid enters the collector through a single inlet and leaves the collector through a single outlet.

2.1.1 Collectors containing more than one inlet and more than one outlet may be tested according to this standard provided that the external piping or ducting can be connected so as to provide effectively a single inlet and a single outlet.

2.2 The heat transfer fluid may be either a liquid or a gas but not a mixture of the two phases.

2.3 This standard contains methods for conducting tests outdoors under natural solar irradiance and for conducting tests indoors under simulated solar irradiance.

2.4 This standard provides test methods and calculation procedures for determining steady-state and quasi-steady-state thermal performance, time, and angular response characteristics of solar collectors.

2.5 This standard is not applicable to those collectors in which the thermal storage unit is an integral part of the collector to such an extent that the collection process and the storage process cannot be separated for the purpose of making measurements of these two processes.

2.6 This standard does not apply to:

(a) those unglazed solar collectors that can be tested in accordance with *ASHRAE Standard 1980 (RA 89)*[1] and

(b) those collectors in which the heat transfer fluid changes phase and can be tested in accordance with *ASHRAE Standard 109-1986 (RA 2003)*.[2] However, a suggested test procedure is given in Appendix I for those phase-change collectors with an integral heat exchanger that satisfy specifications 2.1 and 2.2 and are excluded in the scope of *ASHRAE Standard 109-1986 (RA 2003)*.[2]

3. DEFINITIONS AND NOMENCLATURE

3.1 Definitions

absorber: the absorber is that part of the solar collector that receives the incident radiation energy and transforms it into thermal energy. It may possess a surface through which energy is transmitted to the transfer fluid; however, the transfer fluid itself can be the absorber.

absorber area: the absorber area is the total heat transfer area from which the absorbed solar irradiance heats the transfer fluid or the area of the absorber medium if both transfer fluid and solid surfaces jointly perform the absorbing function.

air mass: the air mass is the ratio of the mass of atmosphere in the actual earth-sun path to the mass that would exist at sea level if the sun were directly overhead.

angle, acceptance: the angular zone within which radiation is accepted by the receiver of a concentrator. Radiation is said to be accepted because radiation incident within this angle reaches the absorber after passing through the aperture.

angle of incidence: the angle of incidence is the angle between the direct solar irradiance and the normal to the aperture plane.

apparent solar time: time based on the apparent angular motion of the sun across the sky, with solar noon the time the sun crosses the meridian of the observer.

area, aperture: the aperture area is the maximum projected area of a solar collector through which the unconcentrated solar radiant energy is admitted.

area, gross: the gross collector area is the maximum projected area of the complete collector module including integral mounting means. (*Note:* The "complete collector module" is the collector unit shipped by the manufacturer for installation on a structure or in an array. However, if the manufacturer requires that additional insulation be placed in any manner along all or any part of the perimeter (edge) of the collector module in order that the performance characteristics, determined with the test procedures herein, will be indicative of those that would occur when the collector is part of an installed system, the gross area will have to be adjusted. If the installed array is specified as a one-row array, then the dimensions are the centerline-to-centerline distance between two adjacent collectors installed in the array times the collector height. If the installed array is specified as a two-row or larger array, the gross area is determined by the horizontal and longitudinal centerline-to-centerline distances of four adjacent collectors installed in the array.)