ANSI/ASHRAE Standard 94.3-1986 (RA 2006)
Reaffirmation of ANSI/ASHRAE Standard 94.3-1986

ASHRAE STANDARD

Method of Testing Active Sensible Thermal Energy Devices Based on Thermal Performance

Approved by the ASHRAE Standards Committee on January 19, 1986, and reaffirmed on January 21, 2006; by the ASHRAE Board of Directors on January 22, 1986, and reaffirmed on January 26, 2006; and by the American National Standards Institute on April 18, 1986, and reaffirmed on January 27, 2006.

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Approved American National Standard
ANSI

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(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process.)

FOREWORD

This is a reaffirmation of ASHRAE Standard 94.3-1986. This standard falls under the Standards Committee classification of Standard Method of Measurement. This standard was prepared under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). It may be used, in whole or in part, by an association or government agency with due credit to ASHRAE. Adherence is strictly on a voluntary basis and merely in the interests of obtaining uniform standards throughout the industry.

Preparation of this standard was done by a group of volunteers representing users, design engineers, manufacturers, scientists, and the federal government. Work sponsored by the U.S. Department of Energy and the Electric Power Research Institute in the solar and off-peak energy programs at government laboratories and universities has been especially helpful. Particular thanks go to Roger Cole of Argonne National Laboratory for his definitive work in creating and preparing this revised standard. James Martin of Oak Ridge National Laboratory and Professor M.W. Wildin of the University of New Mexico made significant contributions.

The changes made for the 2006 reaffirmation were updates to the references.

1. PURPOSE

The purpose of this standard is to provide a standard procedure for determining the thermal performance of sensible thermal energy storage devices used in heating, air-conditioning, and service hot water systems.

2. SCOPE

2.1 This standard applies to sensible-heat-type thermal energy storage devices in which a transfer fluid enters the device through a single inlet and leaves the device through a single outlet. Storage devices having more than one inlet and/or outlet may be tested according to this standard, but each flow configuration involving a single inlet and single outlet must be tested separately. This standard is not applicable to those configurations in which there is simultaneous flow into the storage device through more than one inlet and/or simultaneous flow out of the storage device through more than one outlet. The transfer fluid can be either a noncondensing gas or a liquid.

2.2 This standard does not include factors relating to cost, life, reliability, or the consideration of requirements for interfacing with specific heating and cooling systems.

2.3 The test procedure and equipment outlined in this standard are most easily adaptable to devices used to store thermal energy on the order of 10^7 Btu (10^{10} J) or less.

3. DEFINITIONS

The following definitions are stipulated for this document:*

ambient air: the air in the space surrounding the thermal energy storage device.

buoyancy-inertial parameter: a parameter derived from the dimensionless Richardson number relating fluid inertial forces to buoyancy forces in a storage device. See Equation (8).

charge capacity: the amount of heat that can be transferred into the storage device during a period of time and for a specific set of values for the initial temperature of the storage device, the temperature of the entering fluid, and the mass flow rate of fluid through the storage system.

charge test time: the duration of a single transient test in which energy is added to the storage device.

discharge capacity: the amount of heat that can be removed from the storage device during a period of time and for a specific set of values for the initial temperature of the storage device, the temperature of the entering fluid, and the mass flow rate of fluid through the storage system.

discharge test time: the duration of a single transient test in which energy is removed from the storage device.

heat loss rate: the rate at which heat is lost from the storage device per degree temperature difference between the average storage medium temperature and the ambient temperature (or ground temperature, if the storage device is buried).

standard air: air weighing 0.075 lb/ft^3 (1.2 kg/m^3), which approximates dry air at a temperature of 70°F (21.1°C) and a barometric pressure of 29.92 in. of Hg (101.3 kPa).

standard barometric pressure: the barometric pressure of 29.92 in. of Hg (101.3 kPa) at 32°F (0°C).

storage device: the container(s) plus all contents of the container(s) used for storing thermal energy. The transfer fluid and accessories such as heat exchangers, flow-switching devices, valves, and baffles that are integral with the thermal storage container(s) are considered a part of the storage device.

storage medium: the material in the storage device, independent of the containing structure, in which the major portion of the energy is stored.

stratification index: a parameter that indicates the degree of thermal stratification in a storage device. See Equation (7).

stratified fluid: a region of fluid in which the density decreases monotonically in the upward direction and is stably stratified.

theoretical storage capacitance: the sum of the products of masses and heat capacities of all components (including the transfer fluid) contained within the insulating envelope of the thermal storage device.

transfer fluid: the fluid that carries energy in and out of the storage device.

* Although this standard is written in terms of heat storage, it is applicable to cool storage by reversing the directions of heat flow.