ANSI/ASHRAE Standard 94.1-2002 (RA 2006)
Reaffirmation of ANSI/ASHRAE Standard 94.1-2002

ASHRAE STANDARD

Method of Testing Active Latent-Heat Storage Devices Based on Thermal Performance

Approved by the ASHRAE Standards Committee on June 22, 2002, and reaffirmed January 21, 2006; by the ASHRAE Board of Directors on June 26, 2002, and reaffirmed January 26, 2006; and by the American National Standards Institute on August 14, 2002, and reaffirmed January 27, 2006.

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(This foreword is not a 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 the 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 94.1-2002. 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.

This latent Standard Method of Measurement or Test has been many years under development by a group of volunteers representing users, design engineers, manufacturers, scientists, and the federal government. Work sponsored by the U.S. Department of Energy through government laboratories has been especially helpful in accomplishing this step, particularly by James Martin at Oak Ridge National Laboratory and Roger Cole at Argonne National Laboratory.

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 latent heat thermal energy storage devices used in heating, air-conditioning, and service hot water systems.

2. SCOPE

2.1 This standard applies to latent heat thermal energy storage devices in which a transfer fluid enters the device through a single inlet and leaves the device through a single outlet. This standard is not applicable to those configurations in which there is simultaneous flow into the storage device through more than one inlet or simultaneous flow out of the storage device through more than one outlet. The transfer fluid can be either a liquid or a noncondensing gas.

2.2 This standard does not include factors relating to cost, life, or reliability. It anticipates a variety of energy sources, but does not consider the interfacing requirements of any specific heating or cooling system. In particular, the five cycles prior to testing specified in Section 5.1 are not intended as a measure of phase-change material degradation.

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.

2.4 This standard permits testing of a storage device containing a source of internal heating, such as a stirring pump or an electric immersion heater, provided that less than 10 percent of the charge capacity in a test is supplied by the internal heating. If such a source of internal heating is used, the internal heat input must be measured and Equations (2) and (5) must be appropriately modified.

3. DEFINITIONS

The following definitions are stipulated for this document:

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

charge capacity: the amount of heat that can be transferred into the storage device at a specified rate for a specific set of values for the initial temperature of the storage device, the temperature rise of the exiting 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.

cycling (latent-heat-type storage device): a process in which heat is applied to and removed from the storage device in a cyclic manner and the phase of the storage medium is changed twice in each cycle.

discharge capacity: the amount of heat that can be removed from the storage device at a specified rate and for a specific set of values for the initial temperature of the storage device, the temperature decrease of the exiting 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 coefficient: the rate at which heat is lost from the storage device per degree temperature difference between the average storage medium temperature and the average ambient air 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, which 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.

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

storage efficiency: discharge capacity divided by charge capacity.

4. CLASSIFICATION

Latent-heat-type storage devices are those involving a change of phase of the storage medium. In this type of storage device, most of the heat added to or removed from the system goes into changing the enthalpy of the storage medium during a change-of-phase process. Some heat is also stored as sensi-