Designation: C 870 – 96 (Reapproved 2000)

Standard Practice for Conditioning of Thermal Insulating Materials[1]

This standard is issued under the fixed designation C 870; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the conditioning of thermal insulating materials for tests. Since prior exposure of insulating materials to high or low humidity may affect the equilibrium moisture content, a procedure is also given for preconditioning the materials.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 168 Terminology Relating to Thermal Insulation[2]

E 41 Terminology Relating to Conditioning[3]

E 171 Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials[4]

E 337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)[5]

2.2 *ISO Standard:*[6]

ISO 544 Standard Atmospheres for Conditioning and/or Testing

3. Terminology

3.1 *Definitions*—Definitions of terms in the field of thermal insulating materials are given in Terminology C 168. The following definitions are derived from Terminology E 41:

3.1.1 *moisture content*—the moisture present in a material, as determined by definite prescribed methods, expressed as a percentage of the mass of the sample on either of the following bases: (1) original mass (see 3.1.1); (2) moisture-free weight (see 3.1.2).

3.1.1.1 *Discussion*—This is variously referred to as moisture content, or moisture "as is" or "as received."

3.1.1.2 *Discussion*—This is also referred to as moisture regain (frequently contracted to "regain"), or moisture content on the "oven-dry," "moisture-free," or "dry" basis.

3.1.2 *moisture equilibrium*—the condition reached by a sample when the net difference between the amount of moisture sorbed and the amount desorbed, as shown by a change in mass, shows no trend and becomes insignificant.

3.1.2.1 *Discussion*—Superficial equilibrium with the film of air in contact with the specimen is reached very rapidly. Stable equilibrium can be reached in a reasonable time only if the air to which the sample is exposed is in motion. Stable equilibrium with air in motion is considered to be realized when successive weighings do not show a progressive change in mass greater than the tolerances established for the various insulating materials.

3.1.3 *moisture regain*—the moisture in a material determined under prescribed conditions, and expressed as a percentage of the mass of the moisture-free specimen.

3.1.3.1 *Discussion*—Moisture regain calculations are commonly based on the mass of a specimen that has been dried by heating in an oven. If the air in the oven contains moisture, the oven-dried specimen will contain some moisture even when it no longer shows a significant change in mass. In order to ensure that the specimen is moisture-free, it must be exposed to desiccated air until it shows no further significant change in its mass. For drying temperatures above 100°C (212°F), the moisture content of the oven atmosphere is negligible.

3.1.3.2 *Discussion*—Moisture regain may be calculated from moisture content using Eq 1, and moisture content may be calculated from moisture regain using Eq 2 as follows:

$$R = \frac{C}{100 - C} \times 100 \qquad (1)$$

$$C = \frac{R}{100 + R} \times 100 \qquad (2)$$

where:

C = moisture content, % (see 3.1.1), and

R = moisture regain, % (see 3.1.3).

3.2 *Definitions of Terms Specific to This Standard*—The following descriptions apply only to the usage of terms in this practice:

3.2.1 *conditioned moisture equilibrium*—The moisture condition reached by a sample or specimen during free exposure to moving air controlled at specified conditions. For test purposes, moisture equilibrium must be reached by absorption, starting

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[1] This practice is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.31 on Chemical and Physical Properties.

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[2] *Annual Book of ASTM Standards*, Vol 04.06.

[3] *Annual Book of ASTM Standards*, Vol 14.04.

[4] *Annual Book of ASTM Standards*, Vol 15.09.

[5] *Annual Book of ASTM Standards*, Vol 11.03.

[6] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

from a relatively low moisture content (see 3.2.4). Moisture equilibrium for testing is considered to have been reached when the rate of increase in the mass of a sample or specimen does not exceed that specified for the material being tested. In the absence of a specified rate, an increase of less than 0.1 % of the sample mass after a 24-h exposure is considered satisfactory.

3.2.2 *preconditioned moisture equilibrium*—The moisture condition reached by a sample or specimen after exposure to moving air at the standard atmosphere for preconditioning. The final condition may be established after a specified period of time, or at a moisture equilibrium that is considered to have been reached when the change in mass of a specimen in successive weighings made at intervals of not less than 2 h does not exceed 0.2 % of the mass of the specimen.

3.2.2.1 *Discussion*—Because the standard preconditioning atmosphere covers a range of relative humidities, the close approach to equilibrium is, in general, warranted only at the top of the range. At lower humidities exposure for several hours is usually sufficient.

3.2.3 *standard conditioning atmosphere*—Air maintained at a relative humidity of 50 ± 5 % and at a temperature of 23 ± 2°C (73 ± 4°F). This atmosphere may be used for testing without preconditioning specimens if it has been determined that the property being measured is not affected by the moisture content of the material. Other atmospheric conditions may be specified for specific materials; such conditions and their tolerances will be included in pertinent standards. See Specification E 171 for other suggested atmospheric conditions.

3.2.4 *standard preconditioning atmosphere*—An atmosphere having uncontrolled humidity and a constant temperature within the range from 100 to 120°C (212 to 248°F), or a specified lower temperature if these temperatures would be destructive to the specimens.

3.2.5 See Appendix X1-Appendix X3 for related nonmandatory information.

4. Summary of Practice

4.1 Specimens are brought to a low moisture content in the preconditioning atmosphere, and subsequently brought to conditioned moisture equilibrium in the conditioning atmosphere in accordance with the specified test method.

5. Significance and Use

5.1 The conditioning prescribed in this recommended practice is designed to obtain reproducible test results on thermal insulating materials. Results of tests obtained on these materials under uncontrolled atmospheric conditions may not be comparable with each other. Some of the physical properties of thermal insulating materials are influenced by relative humidity and temperature in a manner that affects the results of tests. In order that reliable comparisons may be made among different materials and products, and between different laboratories, it is necessary to standardize the humidity and temperature conditions to which insulating materials are subjected prior to and during testing.

NOTE 1—In some cases (for example, dimensionally unstable materials), the dry mass cannot easily be established and original mass has to be used.

5.2 It may be important to the user of thermal insulation to know physical properties (influenced by humidity) at the ambient conditions of use, as well as at standard conditions customarily specified for testing. In such instances, those special ambient conditions should be stated in the pertinent material specifications and test methods.

6. Apparatus

6.1 *Conditioning Room or Chamber*:

6.1.1 Equipment for maintaining the standard atmosphere for testing insulating materials throughout the room or chamber within the tolerance given in 3.2.4, and including facilities for circulating the air over the exposed sample or specimen or, alternatively, facilities such as a revolving rack for moving the specimens in the prevailing atmosphere.

6.1.2 Equipment for recording the temperature and relative humidity of the air in the conditioning room or chamber.

6.2 *Instrumentation*, for checking the recorded relative humidity, as directed on Test Method E 337.

6.3 *Preconditioning Cabinet, Room, or Chamber*, equipped with apparatus for maintaining to standard preconditioning atmosphere throughout, within the tolerance given in 3.2.3.

6.4 *Balance*, having a sensitivity of 1 part in 1000 of the mass of the specimen.

7. Procedure

7.1 Determine the temperature and relative humidity of the air in the conditioning room or chamber (6.1) and, if preconditioning is required, in the preconditioning chamber (6.3) in accordance with Test Method E 337. If necessary, adjust the conditions within the specified limits before proceeding to condition the sample or specimen.

7.2 If both preconditioning and conditioning are specified in the test method or in a material specification, proceed as directed in 7.3, 7.4, and 7.5. If preconditioning is not required, condition the sample or specimen as directed in 7.3 and 7.5.

7.3 Expose the specimens or samples in the preconditioning or conditioning atmosphere in such a manner that the moving air will have access freely to all surfaces of the material. Unless otherwise specified in the applicable test method or material specification, expose specimens after cutting and sizing.

7.4 Place the specimen or sample in the standard preconditioning atmosphere. Keep the sample or specimen in this atmosphere until it has attained moisture equilibrium for preconditioning as defined in 3.2.1.

7.5 Place the specimen or sample in the standard conditioning atmosphere as defined in 3.2.4. Keep the sample or specimen in this atmosphere until the material has attained conditioned moisture equilibrium for testing as defined in 3.2.2.

8. Keywords

8.1 conditioning; preconditioning; thermal insulating materials

APPENDIXES

(Nonmandatory Information)

X1. IMPORTANCE OF TEMPERATURE

X1.1 A tolerance of 1°C has been adopted in a number of countries. It is recommended, along with ±2 % relative humidity, by Specification E 171 and ISO 544 on standard atmospheres whenever close tolerances are required. Both temperature and relative humidity can have significant effects on the physical properties of insulating materials. For some properties a change of 1°C may have nearly as much effect as a change of 2 % relative humidity. For organic fibers and foam materials, the temperature effect may be greater than the relative humidity effect.

X2. IMPORTANCE OF PRECONDITIONING

X2.1 The physical properties of a sample at 50 % relative humidity depend upon whether the sample was brought to 50 % from higher or lower relative humidities. This "humidity hysteresis effect" can be 5 to 25 % of the test value for many physical properties. For example, a hysteresis effect of 1.5 % moisture content (or 25 % of the test value of 6 % moisture content) is typical. Preconditioning on the dry side with a humidity range specified would avoid most of the hysteresis effect and result in the moisture content of a given sample being established within 0.15 %, when the sample is later conditioned to 50 % relative humidity and 23°C. Conditioning *down* to 50 % gives most materials a moisture content very nearly the same as conditioning *up* to 60 %.

X2.2 For the sake of obtaining close interlaboratory agreement, especially on physical properties, a specified preconditioning procedure is necessary, but not always sufficient. While preconditioning practically eliminates the hysteresis effect, it has little influence on strain relaxation effects. The latter depends upon the entire previous moisture history of the sample, especially on the conditions of initial drying and tension, and on the duration and degree of subsequent excursions to high humidities (that is, above about 58 % relative humidity). Consequently, for very close interlaboratory agreement, a standardized procedure for handling the sample from manufacture to resting may be required.

X2.3 For production control and similar intralaboratory purposes, the preconditioning step often may be eliminated. For some properties and materials preconditioning may not be necessary, either because of the smallness of the humidity hysteresis effect or because of lower test accuracy requirements.

X3. IMPORTANCE OF ACCURATE RELATIVE HUMIDITY CONDITIONING

X3.1 It is essential that the relative humidity be determined with accuracy and that it be rechecked frequently. The procedure of Test Method E 337 should be followed closely.