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ANSI/ASHRAE Standard 35-2014,  
Method of Testing Desiccants for Refrigerant Drying

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NOTE

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FOREWORD

First published in 1976, ASHRAE Standard 35 was reaffirmed in 1983 and revised in 1992 and again in 2010. The 2010 version included a change to use the Karl Fischer coulometric titrator, a commonly used laboratory instrument, which simplified the test and provides more accurate results than the previous test method.

This current 2014 revision to Standard 35 includes updated references and minor editorial changes. The standard was prepared under the auspices of 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 interest of obtaining uniform standards throughout the industry.

1. PURPOSE

This standard establishes a method of testing desiccants for use in refrigerant drying.

2. SCOPE

2.1 This standard provides a method of testing desiccants only. For testing and rating driers that use these desiccants, refer to ANSI/ASHRAE Standard 63.1, Method of Testing Liquid Line Refrigerant Driers (see Informative Annex A—Bibliography).

2.2 The principle of this standard is to keep a desiccant of known water content in contact with the desired refrigerant until equilibrium has been established under known temperature conditions, after which the water content of the refrigerant is determined.

2.3 This standard is applicable to all desiccants that do not react with the desired refrigerant.

3. DEFINITIONS

For the purposes of this standard, the following terms and definitions apply.

desiccant: a solid that will collect and hold water and is insoluble in the refrigerant medium used.

equilibrium-point dryness (EPD): the water content of a liquid refrigerant after being in contact with a specific desiccant at a particular temperature long enough to reach an equilibrium state. Equilibrium-point dryness (EPD) is expressed as milligrams of water per kilogram of refrigerant (parts per million [ppm]).

water capacity: the amount of water collected and held by the desiccant while maintaining a specified EPD in the liquid refrigerant passing through it at a certain liquid-refrigerant temperature. Water capacity is measured in parts of water per 100 parts of desiccant by weight activated in accordance with the manufacturer’s instructions.

4. CLASSIFICATION

4.1 This method of test is concerned with testing desiccants, specifically with determining the water capacity of a desiccant and the water concentration of a refrigerant when they are in equilibrium.

4.2 Since this standard is concerned only with equilibrium conditions at a given temperature, no consideration is given to the effect of the design of the container holding the desiccant.

Note: In ASHRAE Standard 63.1, the method of testing discussed here, with certain modifications, is used to test the desiccant contained in a completed drier unit to determine its water capacity when in equilibrium with the refrigerant containing a given amount of water. (See Informative Annex A—Bibliography.)

4.3 This method of testing desiccants uses liquid refrigerant in equilibrium with the desiccant.

4.4 The rate of drying is not considered in this standard. Measurements are made under conditions ensuring practical equilibrium.

4.5 Physical characteristics of the desiccant such as particle size, dusting properties, hardness, and the form of desiccant (i.e., molded or granular) are not considered in this standard.

5. APPARATUS

The following apparatus is required for the method of testing in this standard.

5.1 A constant-temperature bath or cabinet that is able to maintain a given temperature with an accuracy of ±1°C (±2°F) and is capable of being set at any temperature within the range of desiccant use. The equilibration vessel may be placed inside a constant-temperature cabinet.

5.2 An analytical balance having a sensitivity of 0.0001 g (2 × 10⁻⁷ lb).

5.3 A pan-type balance having a sensitivity of 0.01 g (2 × 10⁻⁵ lb) and a capacity of 5000 g (11 lb).

5.4 A stainless-steel equilibration vessel with minimum capacity of 300 mL (10 oz). This vessel shall have a maximum working pressure in excess of the anticipated test pressure. The vessel with its associated valve shall be adequately leak tested and dried prior to performing the test.

5.5 A Karl Fischer coulometric titrator. As specified in the titrator instructions, a flowmeter and a 3A molecular sieve drier may be used. Also, a heat source (e.g., a heat gun), a temperature-monitoring device (for equilibration temperatures above room temperature), and a vacuum pump with a micron gauge are required.

Note: The automatic concentration calculation feature of the Karl Fischer coulometric titrator may be used.
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This is a reaffirmation of Standard 35-2014. 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 guidelines throughout the industry. This version of the reaffirmation has no changes.
5.6 Additional apparatus and reagents as required by the method of AHRI Standard 700-2006, Appendix C (2008 revision), Part 2.1

5.7 Crucibles with lids (platinum, fused silica, or porcelain) of sufficient volume to contain 10 g (0.022 lb) of the desiccant being tested.

5.8 A constant-temperature oven capable of maintaining the desiccant activation temperature specified by the desiccant manufacturer within ±10°C (±20°F).

6. PREPARATION AND ANALYSIS

6.1 Preparation of Desiccants

The desiccant shall be prepared as follows.

6.1.1 In this test procedure, desiccant shall be partially hydrated by adding water as vapor to the activated desiccant and then accurately determining the amount added. The performance of the desiccant shall be calculated from a measurement of the water content of the refrigerant at equilibrium with the desiccant containing a predetermined quantity of water.

6.1.2 The desiccant shall be adjusted to approximately the desired water content by weighing the required amount of desiccant on the pan-type balance (see Section 5.3), spreading it in a mono-particle layer, and exposing it to a damp atmosphere. Usually the laboratory atmosphere is sufficiently damp to obtain the desired water content, although care must be exercised so that acid or other chemical vapors are not adsorbed by the desiccant.

6.1.3 Periodically weigh the desiccant to determine when the desired water content has been attained. A fan can be used to circulate the air and increase the rate of adsorption.

6.1.4 Transfer the partially hydrated desiccant to a tared equilibration vessel (see Section 5.4) and weigh it. Hold the equilibration vessel at 77° C (170°F) for 24 hours in order to ensure uniform distribution of the water. If desired, a closed-loop air system can be used under the same conditions. Cool the equilibration vessel containing the partially hydrated desiccant to room temperature. The precise water content is determined by the method in Section 6.2.

6.2 Analysis: Determination of Water Content of Desiccants

Water content of the prepared desiccant shall be determined as follows.

6.2.1 Weigh duplicate samples of approximately 10 g (0.022 lb) of the partially hydrated desiccant on the analytical balance in tared porcelain crucibles. Cover each crucible to avoid the loss or gain of water during the weighing process.

6.2.2 After weighing, the uncovered crucibles with the contained samples shall be heated in a constant-temperature oven at the temperature and for the time specified by the manufacturer as necessary to activate the desiccant.

6.2.3 After the crucibles and contents have been exposed to activating conditions for the required time, they shall be cooled in a closed, dried container and weighed. The loss in weight shall be recorded as parts of water per 100 parts of activated desiccant by weight. This resulting percentage of water in the desiccant represents the water capacity of the desiccant at the resulting EPD's and temperatures determined under the procedures outlined in the test procedure in Section 7.

6.2.4 For purposes of this standard, the water content is considered to be zero when the desiccant is activated in accordance with the manufacturer's instructions.

Note: Activation of a desiccant should not be confused with the widely used test called loss on ignition (LOI), in which a desiccant is heated to temperatures far above its safe activation temperature and the resulting weight loss is determined. This LOI test removes both chemically bound and adsorbed water from the desiccant and results in destruction of the desiccant. The test is used to determine total water and volatile content in a desiccant as a quick quality control test. However, it is never used to determine the usable water capacity of a desiccant, which is the intent of this standard.

Note: Activation of a desiccant is conducted at a temperature that removes adsorbed water but does not remove chemically bound water. Thus the desiccant is not harmed by activation. The activation time and temperature varies for different desiccants and therefore must be specified by the manufacturer.

6.2.5 If duplicate results differ by more than 0.2 parts per 100 parts (0.2 g/100 g), the test shall be repeated.

6.3 Preparation of Refrigerant

6.3.1 Refrigerant meeting the purity specifications of AHRI Standard 700² shall be used in the test under this standard.

6.3.2 The refrigerant shall be charged into the equilibration vessel (see Section 5.4), but to ensure safety, the charge shall not exceed 80% liquid full at the maximum anticipated temperature.

7. TEST PROCEDURE

7.1 Desiccant and refrigerant shall be added to the equilibration vessel by the following procedure.

7.1.1 Water vapor shall be introduced to the desiccant as described in Section 6.1.

7.1.2 Transfer approximately 10 g (0.022 lb) of the partially hydrated desiccant to the equilibration vessel.

7.1.3 Pull a vacuum for about one minute. Then close and cap the valve and weigh the vessel.

7.1.4 Chill the vessel sufficiently to allow refrigerant transfer. Connect the refrigerant liquid supply to the valve using a commercially available nonventing hose that has been thoroughly dried. Place the connected vessel on a suitable balance and weigh it.

7.1.5 Open the valve and add liquid refrigerant to the vessel. Do not add more than 240 mL (8.1 oz) of liquid (80% liquid full) because it may cause a hydrostatic condition in the vessel, possibly resulting in rupture and personal injury. Close the valve.

7.1.6 Close the refrigerant supply cylinder valve and disconnect the flexible line from the equilibration vessel. Cap the vessel to prevent leakage. Weigh the vessel with desiccant and refrigerant and record this value.
7.2 The desiccant and refrigerant shall be equilibrated as follows.

7.2.1 For Capacity at 52°C (125°F): Place the capped vessel in an oven at 52°C ± 1°C (125°F ± 2°F) for at least 48 hours. Weigh the vessel periodically to check for leaks and agitate it lightly by tipping it back and forth a few times.

7.2.2 For Capacity at 24°C (75°F): Store the capped vessel at 24°C ± 1°C (75°F ± 2°F) for at least 48 hours. Weigh the vessel periodically to check for leaks and agitate it lightly by tipping it back and forth a few times.

7.3 The water content of equilibrated refrigerant shall be determined as follows:

7.3.1 If the procedure of Section 7.2.1 was used, remove the vessel from the oven after 48 hours and place it in a heating mantle with temperature control set for 52°C (125°F). Then continue to the procedure of Section 7.3.3.

7.3.2 If the procedure of Section 7.2.2 was used, go directly to the procedure described in Section 7.3.3.

7.3.3 Measure water content according to the method specified in Appendix C of AHRI Standard 700, Part 2.¹

7.4 Water content of equilibrated refrigerant shall be measured in triplicate. If results vary by more than 2 mg/kg (2 ppm) and by more than 10% of the mean, the test shall be repeated.

8. PROOF OF EQUILIBRIUM:
CHEMICAL REACTION

Proof that equilibrium exists or that a chemical reaction may be occurring in a system composed of desiccant, refrigerant, and water shall be obtained for each desiccant with each refrigerant at 52°C (125°F) by the following procedure.

8.1 The equipment containing a desiccant of relatively high water content shall be, at the conclusion of test procedure in Section 7, kept for a period of two weeks at 52°C (125°F).

8.2 The test procedure in Section 7 shall then be repeated.

8.2.1 If the EPD of the second test agrees within 2 mg/kg (2 ppm) or within 10% of that obtained originally, equilibrium as defined by this standard has been proven.

8.2.2 If these results are not obtained, the procedure shall be repeated.

8.3 A persistent and appreciable change in EPD may indicate that a chemical reaction is occurring and thus may mean that the desiccant is not suitable for use with the tested refrigerant.

9. DATA TO BE RECORDED

The number of data points and the format of the reporting form may be determined by the interested parties. The report shall include at least the following information:

- Description of desiccant
- Refrigerant used
- Test temperature
- Water loading percentages for the duplicate samples from Section 6.2
- Water content of equilibrated refrigerant from Section 7.3
- Proof of equilibrium according to Section 8

Note: To fully evaluate desiccant performance, EPD results for multiple water loadings may be presented in graphical form as shown in the 2010 ASHRAE Handbook—Refrigeration, Chapter 7, Figures 1–6 (see Informative Annex A—Bibliography).

This method of testing is not a specification with pass/fail criteria. It is intended for preparation, equilibration, and measurement of desiccant water-adsorption capability for use in such specifications. It is left to the interested parties to establish the pass/fail criteria for test results.

10. NORMATIVE REFERENCES


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INFORMATIVE ANNEX A
BIBLIOGRAPHY


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ASHRAE’s short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its Handbook, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system’s intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE’s primary concern for environmental impact will be at the site where equipment within ASHRAE’s scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.
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