



Standard Test Method for Moisture Content of Paper and Paperboard by Oven Drying¹

This standard is issued under the fixed designation D 644; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the determination of the moisture in all papers, paperboards, and paperboard and fiberboard containers, except those containing matter other than water that is volatile at 105°C.

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.*

NOTE 1—This test method is technically equivalent to TAPPI T 412 – 83.

2. Referenced Documents

2.1 ASTM Standards:

D 585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, or Related Products²

3. Significance and Use

3.1 The moisture content of paper and paperboard may affect the purchase cost and can also have an effect upon the performance of the paper in a given application since moisture content can affect properties including, but not limited to tensile strength, tearing resistance, dimensional instability, permanence, printability, flexibility, and runability on various types of paper processing machinery and equipment. Knowledge of moisture content is necessary to calculate, to a dry basis, analytical results obtained from test specimens weighed at ambient or conditioned moisture content.

4. Apparatus

4.1 *Weighing Container*, airtight, for weighing the specimen before and after drying. A glass weighing bottle with a ground stopper is suitable for specimens of the order of 2 g. The weighing bottle may be of either high or low form; a volume

of about 100 mL is appropriate. An airtight metal container, preferably containing a light-weight large-mesh wire basket, is suitable for larger specimens, particularly those over 10 g.

4.2 *Thermometer*, to indicate the temperature of the drying oven. This thermometer shall include the temperature range from 100 to 110°C, and its scale shall be divided in 1° intervals.

4.3 *Drying Oven*, constant-temperature, equipped with means for ensuring adequate temperature control and air circulation, a means to separate the heating coils from the sample containment area (generally the oven bottom plate), and preferably equipped with means for drying the air entering the oven.

4.4 *Chemical Balance*, sensitive to 1 mg, for weighing specimens of 2 g and under, and sensitive to 0.05 % of the original weight of the specimen for larger specimens.

4.5 *Desiccator*, in which weighing containers and specimens are cooled after drying. It is recommended that anhydrous alumina (indicator grade) be used as the desiccant.

5. Test Specimens

5.1 When moisture is determined for the purpose of calculating the results of a chemical analysis of paper or board on a moisture-free basis, the test specimens shall weigh not less than 1 g, and preferably not less than 2 g each. At the time of initial weighing, these specimens shall be in moisture equilibrium with the samples being analyzed.

5.2 When moisture is determined for the purpose of calculating the amount of moisture in a shipment, the test specimens shall weigh not less than 50 g each, and shall be taken from samples obtained in accordance with Practice D 585.

5.3 When moisture is determined on combined board or containers that are to be tested for other physical properties, test specimens shall weigh approximately 50 g, and shall be taken so as to be representative of the material being tested. In the case of containers, specimens shall be cut from unsealed sections, and preferably from unprinted sections, of the container, and shall be taken from each type of container being tested.

¹ This test method is under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Test Methods.

Current edition approved Feb. 10, 1999. Published April 1999. Originally approved in 1955. Last previous edition approved in 1994 as D 644 – 94.

² *Annual Book of ASTM Standards*, Vol 15.09.



6. Procedure

6.1 Determine the tare weight of the oven-dried weighing container as follows: Heat the open container (container, stopper or cover, and wire basket, if any) in the oven at $105 \pm 3^\circ\text{C}$ for 1 h. At the end of that period, quickly close the container, remove it from the oven, and place it in the desiccator to cool for 1 h. Remove the closed container from the desiccator, momentarily loosen the cover to equalize the pressure, and then weigh the container.

6.2 Transfer the test specimen to the tared weighing container as soon as the specimen is withdrawn from the sample of material under test, and close the container immediately. Great care must be taken to avoid change in moisture content during the transfer of the specimen from the sample to the container. Handle the specimen with tweezers or clean, dry rubber gloves. If a delay of over a second or two in transferring the specimen to the container is unavoidable, keep the specimen covered on both sides with several adjacent layers of the paper or board from which it is withdrawn, until it can be placed in the container. Then discard the protecting layers of paper or board. Unless the specimen is later to be spread out in the oven, avoid filling the container tightly. Weigh the closed container holding the test specimen, to allow calculation of the original weight of the specimen. The weighing container should not be touched with the fingers during these manipulations.

6.3 Remove large specimens from the container. If the container has a removable basket, leave the specimen in the basket, and place the basket and open container in the oven. If the container does not have a removable basket, spread the specimen in a basket or tray that will permit free circulation of air around the specimen, and place the basket or tray and the open container in the oven. Heat for 2 h at $105 \pm 3^\circ\text{C}$. Replace the specimen in its container and close the container, doing this, if possible, without removing the specimen from the oven. Place the closed container in the desiccator, and allow it to cool for 1 h. Loosen the top of the container momentarily to equalize the pressure, and then weigh the container to allow calculation of the oven-dry weight of the specimen.

6.4 Place small specimens in the drying oven without removing them from the weighing bottle, remove the stopper of the bottle, heat for 1 h at $105 \pm 3^\circ\text{C}$, close the bottle in the oven, cool to room temperature in the desiccator, and weigh. Remove the stopper momentarily just before weighing to equalize the pressure.

6.5 Repeat the required drying and weighing operations until the difference in weight between two successive weighings is not more than 0.1 % of the weight of the specimen.

6.6 Make all weighings to the nearest 1 mg for specimens of the order of 2 g, and weigh to within 0.05 % of the weight of the original specimen for specimens over 2 g.

7. Calculation

7.1 When the percentage of the moisture based on the original weight is required, calculate it as follows:

$$\text{Moisture, \%} = [(W_1 - W_2)/W_1] \times 100 \quad (1)$$

where:

W_1 = original weight of the specimen, and
 W_2 = weight of the specimen after oven drying.

7.2 When the percentage of moisture based on the oven-dry weight is required, calculate it as follows:

$$\text{Moisture, \%} = [(W_1 - W_2)/W_2] \times 100 \quad (2)$$

where:

W_1 = original weight of the specimen, and
 W_2 = weight of the specimen after oven drying.

8. Report

8.1 Report the moisture as the percent loss in weight of the specimen to the nearest 0.1 %, on the basis of the original weight (7.1) or on the oven-dry basis (7.2).

9. Precision and Bias

9.1 Precision:

9.1.1 *Repeatability*— The repeatability standard deviation of the procedure in this test method is approximately 0.12 %, and the 95 % repeatability limits are 0.35 %.

9.1.1.1 The above repeatability values are based on TAPPI Collaborative Reference Program Reports 61 through 70. The number of laboratories reporting the data contained in these reports ranges from 10 to 16.

9.1.2 *Reproducibility*— Based upon the data cited in 9.1.1.1, reproducibility standard deviations may range from 0.12 % to 0.55 % with a corresponding range of 95 % reproducibility limits from 0.4 % to 1.5 %.

9.1.2.1 Reproducibility of results between laboratories is dependent upon the care taken to follow Section 6 exactly, and particularly the care taken with regard to 6.2.

9.1.3 Variations in ambient humidity may affect the humidity in the oven and therefore results of this test method. For very critical work, precision may be improved by placing the oven in a controlled humidity environment.

9.1.4 The user of this precision data is advised that it is based on actual mill testing, laboratory testing, or both. There is no knowledge of the exact degree to which personnel skills or equipment were optimized during its generation. The precision quoted provides an estimate of variation in test results which may be encountered when the method is routinely used by two or more parties.

9.2 *Bias*—The procedure in this test method has no bias because the value of moisture content is defined in terms of the testing conditions specified, and there is no determining bias. Determination of moisture content under conditions other than those specified in this test method may give different results.

10. Keywords

10.1 moisture; oven drying; paper; paperboard; water



D 644 – 99 (2002)

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).