Designation: D4843 – 88 (Reapproved 2016)

Standard Test Method for Wetting and Drying Test of Solid Wastes[1]

This standard is issued under the fixed designation D4843; 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 test method covers procedures for determining material losses produced by repeated wetting and drying of solid waste specimens. It also covers the visual observation of the disintegration of solid specimens.

1.2 This test method intends that the material used in the procedure be physically, chemically, and biologically representative; hence it does not address problems as a result of the inhomogeneity of specimens.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *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:*[2]

C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

3. Significance and Use

3.1 This test method is intended for the evaluation of the wetting and drying resistance of monolithic, solid, solidified/stabilized wastes under the testing conditions of this test method.

3.2 This test method may be used for the comparison of wetting and drying resistance of wastes.

3.3 Data tabulated in Table 1, Table 2, and Table 3 may be used to observe irregularities caused by inhomogeneity of specimens, or comparison of mass loss-cycle relations of different wastes, or both, as well as to measure method-related mass losses such as matrix dissolution.

4. Apparatus

4.1 *Disposable Molds,* 44 mm inside diameter by 74 mm in length.

4.2 *Balance or Scale,* with a capacity at least 50 % greater than the mass of the specimen and beaker, and a sensitivity of 0.01 g.

4.3 *Drying Oven,* a thermostatically controlled drying oven capable of maintaining a temperature of 60 ± 2°C; to be used for drying moisture specimen and for the solids content determination.

4.4 *Oven,* capable of maintaining a temperature of 60 ± 3°C; at a nitrogen purge rate specified in 4.5.

4.5 *Flow Controller,* to set nitrogen purge flow at a rate that will give 30 ± 5 min residence time.

4.6 *Moisture Chamber,* a suitably covered container capable of maintaining a temperature of 20 ± 3°C and minimum 95 % relative humidity, for preconditioning specimens.

4.7 *Beakers,* 400-mL size (narrow type), to store sample and to collect particulates.

4.8 *Tongs,* to handle samples.

5. Sample Preparation

5.1 *Specimen Size*—44 mm diameter by 74 mm in length.

5.1.1 Specimens may be cut to size from larger samples.

5.1.2 Specimens can also be molded in disposable plastic molds. When molding specimens refer to Practice C305 (see 2.1).

NOTE 1—Practice C305 refers to pastes and mortars. Molding materials with different consistency may require modifications and may result in different precision.

5.2 Condition samples that are not molded for this test in the moisture chamber for a period of seven days.

5.2.1 Samples molded for this test have to be cured in the moisture chamber for a period of 28 days.

[1] This test method is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.06 on Analytical Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

TABLE 1 Control Group

Laboratory:
Technician:

Sample name:
Sample Id No.:
Test Start Date:

Sample 1 / Cycle No.	1					2					3				
Date	$T_{i,c,1}$	$B_{i,c,1}$	$W_{i,c,1}$	$M_{c,1}$	$R_{i,c,1}$	$T_{i,c,2}$	$B_{i,c,2}$	$W_{i,c,2}$	$M_{c,2}$	$R_{i,c,2}$	$T_{i,c,3}$	$B_{i,c,3}$	$W_{i,c,3}$	$M_{c,3}$	$R_{i,c,3}$
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															
11.															
12.															

TABLE 2 Sample Group

Laboratory:
Technician:

Sample name:
Sample Id No.:
Test Start Date:

Sample 1 / Cycle No.	1					2					3				
Date	$T_{i,s,1}$	$B_{i,s,1}$	$W_{i,s,1}$	$M_{s,1}$	$R_{i,s,1}$	$T_{i,s,2}$	$B_{i,s,2}$	$W_{i,s,2}$	$M_{s,2}$	$R_{i,s,2}$	$T_{i,s,3}$	$B_{i,s,3}$	$W_{i,s,3}$	$M_{s,3}$	$R_{i,s,3}$
1.															
2.															
3.															
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12.															

6. Procedure

6.1 Select one specimen for moisture content determination.

6.2 Determine moisture content of sample with Test Method D2216 but revised to use a temperature of 60 ± 3°C (see 2.1).

6.3 Select three specimens for testing and three for control and mark them respectively.

6.4 Weigh specimens (accuracy to 0.01 g).

6.5 Place each specimen into a beaker of known tare mass (accuracy to 0.01 g) and cover it.

6.5.1 Use watch glass or plastic wrap.

6.5.2 The tare mass of beaker shall be determined after drying in accordance with Test Method D2216.

6.6 Place the three beakers containing the testing specimens in an oven. Maintain the temperature at 60 ± 3°C for 24 h while purging the oven with nitrogen gas at the controlled flow rate corresponding to 30 ± 5 min residence time.

6.6.1 In order to remove moisture from the nitrogen stream, a water-cooled condenser and condensate collection flask may be used downstream from the oven.

6.7 Store the three beakers with the control specimens in the moisture chamber at 20°C for 24 h.

TABLE 3 Relative Weight Loss

Laboratory:
Technician:

Sample name:
Sample Id No.:
Test Start Date:

Cycle No.	$\bar{R}_{i,s}$	$\bar{R}_{i,c}$	$\bar{C}_i$	$\bar{S}_i$	Observations
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
$\bar{S}$					

6.8 Remove the specimens from the vacuum oven and the moisture chamber. Allow 1 h for the sample to cool to room temperature. Add 230 mL distilled water to the beaker to fully cover the specimens.

6.8.1 Add laboratory temperature water 20 ± 3°C.

6.9 Place a watch glass or plastic wrap on the beakers and store the water covered specimens at 20 ± 3°C for 23 h; then transfer them to new beakers prepared according to 6.5.

6.9.1 Use tongs to transfer specimens. Excessive tong pressure may result in premature failure or damage specimen.

6.10 Remove any loosely attached particulates by spraying distilled water from a wash bottle to the surface of specimen (10 to 20 mL distilled water). Let the water drain into the beaker of origin.

6.11 Conduct visual observation on the specimens' physical deterioration including: cracking, fracturing, integrity, and surface roughness.

6.12 Determine the specimens' mass loss; solid content in beakers by evaporating water at 60 ± 3°C in drying oven.

6.13 Correct the average relative mass loss of samples using the average relative mass loss of control specimens.

6.14 Repeat the procedures in 6.5 through 6.10 eleven additional times, for a total of 12 cycles.

6.15 Terminate experiment of all specimens if the corrected cumulative mass loss of any of the specimens exceeds 30 % (failure), and note the number of cycles survived.

7. Calculation

7.1 Calculate the dry mass of the specimens as follows:

$$M_s = \left(1 - \frac{w}{100\,\%}\right) M_{sw} \quad (1)$$

where:

M_s = oven dry mass of specimen, g
M_{sw} = initial mass of specimen, g, and
w = moisture content, %.

It is assumed that the moisture contents of specimens are identical. Oven dry masses of sample and control specimens are calculated on that basis.

7.2 Calculate corrected mass loss of specimens after each cycle. Express mass loss in percent of initial calculated oven-dry mass. Calculate average cumulated corrected mass loss of specimens after each cycle.

$$W_{i,s,j} = T_{i,s,j} - B_{i,s,j} \quad (2)$$

where:

$W_{i,s,j}$ = mass loss of sample j during cycle i, g,
$T_{i,s,j}$ = oven-dry mass of beaker and residue of sample j after cycle i, g, and
$B_{i,s,j}$ = oven-dry mass of beaker for sample j before cycle i, g.

$$W_{i,c,j} = T_{i,c,j} - B_{i,c,j} \quad (3)$$

where:

$W_{i,c,j}$ = mass loss of control j during cycle i, g,
$T_{i,c,j}$ = oven-dry mass of beaker and residue of control j after cycle i, g, and
$B_{i,c,j}$ = oven-dry mass of beaker for control j before cycle i, g.

$$R_{i,s,j} = \frac{W_{i,s,j}}{M_{s,j}} \quad (4)$$

where:

$R_{i,s,j}$ = relative mass loss of sample j during cycle i, %,
$W_{i,s,j}$ = mass loss of sample j during cycle i, g, and
$M_{s,j}$ = oven-dry mass of specimen j, g.

$$R_{i,c,j} = \frac{W_{i,c,j}}{M_{c,j}} \quad (5)$$

where:

$R_{i,c,j}$ = relative mass loss of control j during cycle i, %,
$W_{i,c,j}$ = mass loss of control j during cycle i, g, and
$M_{c,j}$ = oven-dry mass of control j, g.

$$\bar{R}_{i,s} = \frac{\sum_{j=1-3} R_{i,s,j}}{3} \quad (6)$$

where:

$\bar{R}_{i,s}$ = average relative mass loss of samples ($j = 1 - 3$) during cycle i, %, and
$R_{i,s,j}$ = relative mass loss of sample j during cycle i, %.

$$\bar{R}_{i,c} = \frac{\sum_{j=1-3} R_{i,c,j}}{3} \quad (7)$$

where:

$\bar{R}_{i,c}$ = average relative mass loss of control ($j = 1 - 3$) during cycle i, %, and
$R_{i,c,j}$ = relative mass loss of control j during cycle i, %.

$$\bar{C}_i = \bar{R}_{i,s} - \bar{R}_{i,c} \quad (8)$$

where:

$\bar{C}_i$ = average corrected relative mass loss of samples ($j = 1 - 3$) during cycle i, %,
$\bar{R}_{i,s}$ = average relative mass loss of samples ($j = 1 - 3$) during cycle i, %, and
$\bar{R}_{i,c}$ = average relative mass loss of control ($j = 1 - 3$) during cycle i, %.

$$\bar{S}_i = \sum_{i=1-i} \bar{C}_i \quad (9)$$

where:

$\bar{S}_i$ = average cumulated, corrected relative mass loss of samples after i cycles, %, and
$\bar{C}_i$ = average corrected relative mass loss of samples ($j = 1 - 3$) during cycle i, %.

$$\bar{S} = \sum_{I=1-12} \bar{C}_i \quad (10)$$

where:

$\bar{S}$ = average cumulated, corrected relative mass loss of samples after 12 cycles, %, and
$\bar{C}_i$ = average corrected relative mass loss of samples ($j = 1 - 3$) during cycle i, %.

8. Report

8.1 Report the following information:

8.1.1 Moisture content of specimens.

8.1.2 Average cumulative, corrected relative mass loss after 12 cycles. ($\bar{S}$)

8.1.3 Number of cycles survived if the specimens did not survive 12 cycles of testing.

8.1.4 Results of visual observation after each cycle (physical deterioration).

9. Precision and Bias[3]

9.1 The precision of this test method, in terms of standard deviation, was determined in an interlaboratory experiment involving five laboratories, two types of samples, and respective controls. Duplicates of samples and controls were measured in each laboratory.

9.2 The precision of this test method can be expressed as follows:

Sample Code	Mean ($\bar{X}$)	Standard Deviation(s)
LFP	0.024	0.038
CFP	0.112	0.138

9.3 The precision of this test method may be dependent on the level of the properties measured.

[3] Supporting data are available from ASTM Headquarters. Request RR:D34-1004.