International Wastewater Services Flushability Group

IWSFG PAS 3A: 2017 – Disintegration Test Methods – Accelerated Bench Top Disintegration Test

PUBLIC COMMENT VERSION

Forward

The International Wastewater Services Flushability Group (IWSFG) is a worldwide coalition of national and regional wastewater services' Associations and Organizations and individual wastewater services.

The work of preparing the standards is carried out by various drafting groups comprising volunteers designated by the principal and the supporting participants of the group. They participate on a voluntary basis, without remuneration of any kind.

> *The criteria for flushability and the test methods are the product of a global consensus of the coalition members and reflect the hydraulic, mechanical and environmental conditions of drain lines, various onsite treatment and wastewater collection and treatment systems as well as the receiving waters for treatment plant effluents*

The task of the group was to prepare standards reflecting the above purpose.

Wastewater services are organizations acting for the public good as a public service. The group expects the manufacturers and distributers of their products to act in a socially responsible and environmentally sustainable manner by adhering to the established standards.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The IWSFG shall not be held responsible for identifying any or all such patent rights.

Contents

1 Introduction

Wastewater process systems are designed to receive, treat, and convey sanitary discharges that, after treatment, are subsequently disposed of as:

a. liquid effluents to the aquatic environments of lakes, rivers, and oceans
b. solid residuals (biosolids) for application to land for their inherent nutrient values
c. solid residuals incinerated or digested for energy recovery
d. solid residuals sent to landfill sites.

Typical waste streams include toilet paper, human waste, food waste, detergents and cleaning agents. In recent years, new products such as moist wipes and toilet bowl cleaning products have been introduced worldwide - many of these are identified as “flushable” products. Other products such as tampons, condoms, and facial tissues are commonly but inappropriately flushed. The physically adverse effects of such products on wastewater systems (clogging and plugging) have been identified but numerous other environmental effects have not been studied systematically. For example, various flushed products may comprise materials and chemicals that can be harmful to the environment; hence, such products should not be identified as “flushable”. Accordingly, the purpose of the flushability test along with others presented in this IWSFG series is to define the qualities and characteristics of those products that may be incorrectly considered as being “flushable”. By adhering to these test methods and providing the appropriate advice to the product users regarding the after use disposal of such products will ultimately lead to the long-term sustainability of wastewater systems and the minimization of potential problems such as pipe blockages and equipment failures in sewer networks.

The goal of the IWSFG is not to ban the production and/or use of these products, but to encourage manufacturers to identify those products that do not meet the established IWSFG standards set as not being “flushable” and to encourage users to dispose of such products after use in a more appropriate manner.

2 Purpose

The purpose of this test is to assess the performance, i.e. disintegration, of a product when it is subjected to the hydraulic forces generated by mechanical forces over a short duration.

NOTE: This test resembles two existing toilet paper tests [1], [2], which have been traditionally used to test toilet papers. Since toilet papers historically have not caused clogging, or plugging, problems in wastewater systems, the IWSFG has benchmarked its tests for flushability to toilet paper performance, particularly in respect to its disintegration.

3 Scope

The scope of this PAS includes all of those products that a manufacturer or distributer may wish to identify as being flushable and all products, which by the location of their use and likely contamination by human excreta, are likely to be flushed through a toilet into a drain line and wastewater conveyance and treatment system.

4 References

4.1 Normative References

IWSFG PAS 0:2017 *Terms and Definitions for Determination of Flushability*

4.2 Informative References or Relevant Annexes

Annex 1 - Screw Propeller Specifications
Annex 2 - Sources of Apparatus
Annex 3 - Procedure for Pre-rinsing Test Products for Determining Initial Dry Mass
Annex 4 - Sieving and Recovery of Product Residues
Annex 5 - Drying and Weighing of Products and Product Residues

5 Terms and Definitions

See: IWSFG PAS 0:2017 *Terms and Definitions for Determination of Flushability*

6 Principles

The flushability test is used to demonstrate a product's potential to rapidly disintegrate in water when subjected to brief but significant hydraulic forces that are generated mechanically.

This method uses an agitating device consisting of a propeller mounted in a beaker and operated at a speed of 800 rpm. The product, or a portion of the product, is placed in a beaker and is agitated by the vortex created by the propeller for 2 minutes. Then the content of the beaker is poured onto a 6.3 mm perforated sieve to confirm its disintegration.

Note: The test is undertaken in potable water, as opposed to wastewater because:

a. It avoids the health and safety issues associated with wastewater.
b. It avoids the inconsistencies that would inevitably be found between two or more samples of wastewater.

7 Apparatus

The apparatus used comprises:

a. a transparent beaker having a flat bottom, an internal diameter of 98 mm ± 5 mm, and a total height of 150 mm
b. a pourer spout having sufficient capacity to contain 600 ml of water
c. tap water
d. a stopwatch with an accuracy of 0.1s
e. an agitating device with a rotation speed of 800 rpm ± 20 rpm, which is equipped with a polytetrafluoroethylene (PTFE) screw-propeller (The technical description of the propeller is given in Annex 1, Figure 1.)
f. a perforated plate screen with round holes, compliant with ISO 3310-2, with apertures of 6.3 mm [3]
g. a shower head attached to a faucet (tap) with a regulator adjusted to deliver 4 L per minute

8 Preparation

8.1 Sample Acquisition

For products already in the market place, the testing laboratory shall select and acquire sample products from retail outlets (e.g., grocery stores or pharmacies).

For products under development as new or improved products, the testing laboratory may receive samples from their manufacturers or their intended distributers.

The test report shall clearly indicate the applicable method of sample acquisition or its purpose.

8.2 Number of Test Pieces

Five (5) specimens are required for each complete testing.[1] Specimens should be obtained from at least two distinct packages of a product. To obtain 5 specimens, the rolls of toilet paper, or bundles of moist tissues in its original packages, should be divided into 5 equal sections. Then, one specimen from each section will be used for testing.

For toilet papers, the starting point, as well as the end point of a toilet paper roll should be avoided due to the glue effect.

To obtain moist tissue specimens, it will be convenient to cut open their packaging on its side to view the whole bundle of moist tissues. Then, the package will be divided into 5 equal sections, and a specimen will be removed from each section.

[1] Note: In order to prepare for the possibility that the alternate dry mass test verification is required, 5 additional specimens should be acquired.

Caution is necessary to not damage delicate specimens when removing them from the package. Specimens must also be removed just before testing starts to prevent their contamination by particles in the ambient air.

8.3 Sample preparation

The following requirements apply to the specimens to be tested.

8.3.1 Dry tissues:

The specimen size shall be either one (1) or two (2) sheets of toilet paper depending on their dimensions so that the total area is approximately 180-300 $cm^{2.}$. For toilet paper, the specimen shall be taken from the roll, avoiding the beginning and the end of the roll to avoid the possible presence of glue. Fold the strip in two through the middle of the strip and leave the two parts folded one over the other, as per Section 8.2.

The dry facial tissue samples shall be taken from the package and the specimen shall consist of one sheet, as per Section 8.2.

8.3.2 Moist tissues:

The specimen size shall be one sheet, or if the wipe exceeds 300 cm^2 a piece 13 cm X 20 cm or 260 cm^2 that is taken from the center of the product according to Sections 8.1 and 8.2.

Moist products must be tested as soon as they are removed from the packaging in order to minimize the evaporation of the lotion, or moisturizing chemicals, from the specimen. No attempt to remove the lotion should be made and the removed tissue should not be left exposed for any length of time, which would allow the lotion to start evaporating.

8.3.3 Other products

For other products, the sample shall be taken directly from the packaging as per section 8.2. If the specimen is large and thereby cannot be inserted into the beaker, then a representative shape and size of the specimen should be obtained by cutting its edges to obtain a volume from 2 to 4 cm^3 and a mass of 1 to 3 grams.

8.4 Apparatus

The rotational speed of the propeller should be verified as operating at 800 rpm.

9 Storage and Conditioning

9.1 Storage of samples

Samples shall be stored under ambient laboratory conditions in the manufacturer's original packaging.

However, if the samples have been removed from the manufacturer's original packaging, the samples shall be identified and stored as follows:

1. Dry products should be returned to their original packaging, and should be double-bagged with resealable plastic bags.
2. Moist products should be returned to their original packaging, e.g., hard-plastic containers or soft-plastic packages.
3. In case of hard-plastic boxes, the box should be closed, and then should be double-bagged with plastic resealable plastic bags to minimize any exposure to the ambient air.
4. Soft-plastic packages should be closed tightly after squeezing the air out of the package, and then they should be double-bagged with resealable plastic bags to minimize the potential exposure to ambient air.
5. Samples should then be stored in secured laboratory cabinets.

9.1 Conditioning for the test

There are no conditioning requirements. The test specimens should be removed from their packagings (if any) and used immediately in the test procedure.

10 Procedure

10.1 Summary

The test consists of 5 agitation sequences with the specimens meeting the conditions set out in Section 6. After each agitation, observations are made regarding whether the specimen has disintegrated to the degree previously set.

10.2 Test procedure

The following steps should be undertaken:

1. Start with an empty beaker with dry walls.
2. Place the specimen in the bottom of the beaker, possibly covering all the bottom of the beaker and a part of the walls.
3. Put the screw-propeller in a centered position, at 50 ± 5 mm from the bottom of the beaker (see Annex 1, Figure 2).
4. Turn the agitating device on without water to a speed of 800 rpm.

5. Pour the 600 ml ± 10 ml water into the beaker, along the rotating axis of the agitating device (in order to minimize the perturbations due to the contact between the specimen and the water), in less than 5s. Verify that the specimen is driven under the screw-propeller.
6. Start the timer as soon as all the water is completely poured into the container.
7. Stop the agitating device after 2 minutes.
8. Slowly pour the contents of the beaker evenly onto the surface of the 6.3 mm perforated plate sieve and rinse the beaker as necessary to remove all of its contents. The distance between the beak of the beaker and the top surface of the sieve should be approximately 10-15 cm.
9. Take photographs of the upper and lower sieve surfaces.
10. Take the shower head and turn on the faucet and adjust the regulator to a flow rate of 4 L per minute.
11. With the handheld showerhead spray nozzle held approximately 10-15 cm above the top surface of the sieve, gently rinse smaller materials through the 6.3 mm sieve. Constantly move the spray over the entire surface without concentrating the spray on any specific areas. Do not force the passage of any material through the sieve.
12. Stop the rinsing after 1 minute.
13. Observe if there are any residuals of the specimen on the top and/and back surface(s) of the sieve.
14. Take photographs of the upper and lower surfaces of the sieve:
    a) If there are no specimen residuals on the sieve, the test is complete and the product has passed.
    b) If there are residuals remaining visually and quantitatively, recover all the retained materials from both sides of the sieve using forceps or by backwashing the material into a smaller sieve and then using forceps. (See Annex 4). Transfer these materials into labeled drying pans or tared weigh boats to determine their dry weight (See Annex 5).
15. Repeat the procedure 4 times with a new test piece.

10.3 Test Termination

Upon completion of a round of testing, the flasks shall be drained and cleared of any residuals from the specimens.

In cases where specimens contain fiber-binding chemicals that are likely to remain on the walls of the flasks or on the sieve surfaces, the flasks and sieve surfaces shall be washed using solvents such as ethanol and methanol, or soap and water.

10.4 Test Results

The test must be repeated with 5 specimens.

a. If 4 or more of the 5 tested specimens show that there are no residual fragments remaining on the 6.3 mm sieve after rinsing, the product will pass.
b. Record the test results for each one of the 5 specimens. Collect any residual fragments that remained on the 6.3 mm sieve during each test. Quantify the dry-mass of all residual fragments from 5 specimens by drying the fragments at 103 °C for 4 to 8 hours. For a product to pass, the total dry-mass of the residual fragments (>6.3 mm of solids) must be less than 5 % of the average initial dry mass calculated dry-mass of 5 specimens.

(See Annexes 3, 4, and 5 for the procedure to be followed)

10.5 Calculations

The following calculations are required for products in Section 10.2.14 a:
In 4 out of 5 tests, no fragments should be visible on the sieves.

The following calculations are required for products in Section 10.2.14 b:
The percentage of each article's mass that disintegrated (operationally defined by the ability to pass through the 6.3 mm sieve) is calculated using the following equation:

$$\%\ \text{Disintegration} = \left[1 - \frac{\text{total dry mass of retained fraction in sieve (g)}}{\text{total initial dry mass of sample (g))}} \right] \times 100$$

(See Annexes 3, 4, and 5.)

11 Acceptance criteria

To be acceptable:

a. The fragments from four (4) of the five (5) test specimens at the end of the 2-minute test must clear completely (100% pass through) the 6.3 mm sieve after the 1 minute rinse as per Annex 4, i.e., No fragments on the sieve should be observed; this result must be supported with a visual examination and pictures of the solids on the sieve.

b. If there is material left on the 6.3 mm sieve after the 1 minute rinse as per Annex 3, the percentage of the total initial dry mass of the five (5) test specimens (as computed in Step b of Section 10.5) passing through the 6.3 mm sieve after 120 minutes of testing must be greater than 95%. This result must be supported with a visual examination and pictures of the solids on the sieve.

12 Test report

The Flushability test report should include the following information:

1. a reference to this test procedure
2. an overview of this test procedure
3. the date and location of testing
4. a complete identification of the tested product with sufficient details to identify the product
5. a statement as to the acquisition process followed and the purpose of testing
6. the original dimensions and weight of the product
7. any departure from the standard procedure and any circumstances that may have affected the results along with an explanation
8. copies of any photographs taken during the procedure
9. the test results, including:
    a. the number of tests in which the fragments, if any, did not pass through the sieve
    b. photographs of the upper and lower surfaces of the sieve,
    c. the percentage of dry mass which passed through the 6.3 mm sieve after 1 minute of rinsing, and
    d. a final statement indicating whether the product passed or failed the test.

13 Precision

There may be some variation in the quality of the products being tested, which is why 5 separate specimens shall be acquired, according to Sections 8.1 and 8.2.

Bibliography

[1] *AFNOR - NF Q34-020 Sanitary and Domestic Articles. Toilet Paper. Measurement of Disintegration,* Association Française de Normalisation, Paris, France. 1998-08-01

[2] *JIS P 4501:1993/AMENDMENT 1:2006, Toilet Tissue Papers*, Japan Industrial Standard, Japanese Standards Association, 03/25/2006

[3] *ISO 3310-2:2013 Test sieves -- Technical requirements and testing -- Part 2: Test sieves of perforated metal plate*

Annex 1 – Screw Propeller Specifications

(Normative)

The propeller is made of a 60 mm ± 1 mm diameter cylinder with a 17 mm ± 1 mm total height.

On one side, 4 ribs with a triangular section cross each other, having geometrical properties and dimensions as reported on Figure 1.

The screw-propeller is centered with respect to the rotating axis of the agitation device and is fixed through its flat upper side to this axis.

The agitating device permits the up and down movements of the rotating axis and the propeller in order to position the rotor at a specified fixed position (see Figures 1 and 2).

The power of the agitating device must be sufficient to provide a constant speed when the rotor is immersed in water.

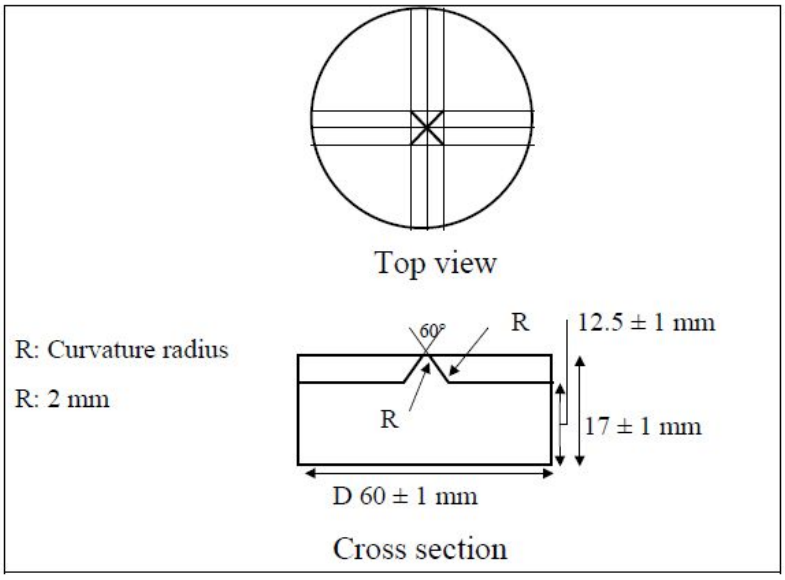
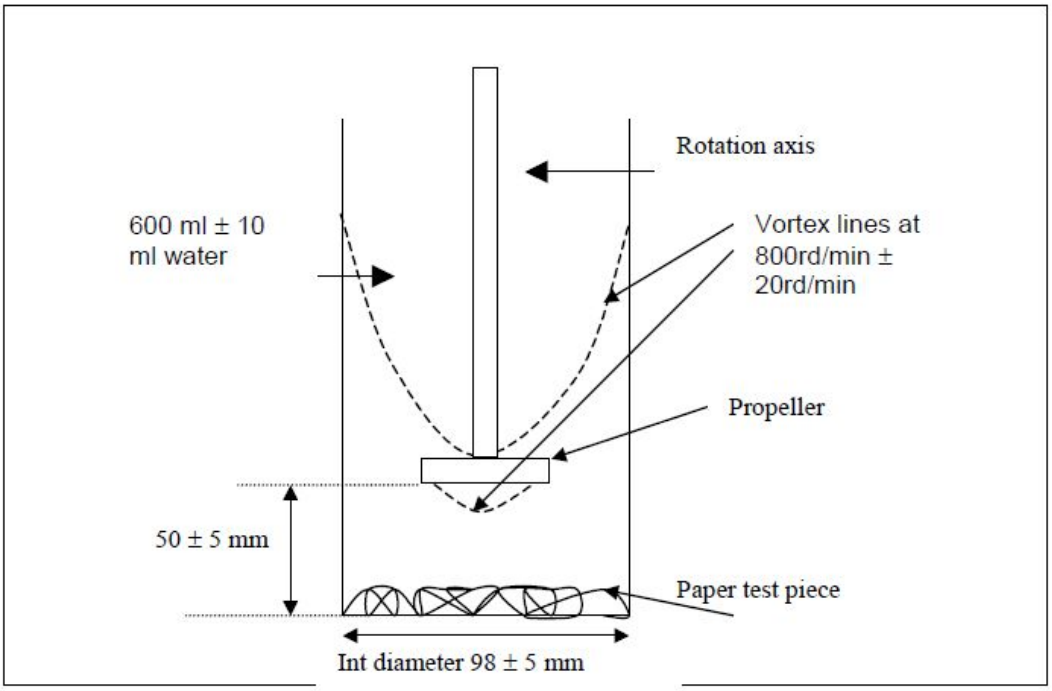


Figure 1: Screw-propeller

Source: French National Standard



382

383 Figure 2 – Screw-Propeller

384 SOURCE: French National Standard

Annex 2 – Sources of Apparatus

(informative)

All of the apparatus is generally available from larger laboratory supply firms.

For example:

a. The propeller can be obtained from OpTest Equipment Inc. (www.optest.com/)
b. The mixer can be obtained from Southwest Scientific Inc. (http://www.southwestscientific.com/)
c. The 6.3 mm sieve can be obtained from Retsch GmbH, Solutions in Milling and Sieving. (http://www.retsch.com/products/sieving/test-sieves/)

All of the equipment can be obtained from Enrico Toniolo S.r.l., Milano, Italy (http://www.tonioloenricosrl.com/en/)

Annex 3 - Procedure for Pre-rinsing the Test Products for Determining Initial Dry Mass

(Informative)

A.3.1 Introduction

This Annex describes two approaches for pre-rinsing the test products to remove water soluble lotions, or other additives, from the products before using them in the determination of the initial dry mass. The first method, which is recommended, involves flushing the products down a toilet and through a drain line using tap water. This approach simulates the actual rinsing process that occurs when a product is flushed on its way to a wastewater conveyance system. When a toilet and drain line are not available, an alternative method can be used that involves swirling the products in a container of tap water.

A.3.2 Test Product Selection

- When conducting a test to support a flushable claim, the products used for testing must be the same as those offered in the intended market.
- Obtain a sufficient number of products (samples) to conduct the intended tests.
- If there is a need to determine the average dry weight for the product, at least five more samples will be needed, and when samples exhibit high variability in their weight, more may be needed.
- Test specimens should be randomly obtained from different sections of one or more packages to ensure that they are broadly representative. This is particularly important for products such as wipes, which occur in a roll or stack.

A.3.4 Toilet and Drain Line Method

A.3.4.1 Equipment

- Use a toilet and drain line as per IWSFG PAS 2A:2017, with catch basket positioned before the drain.
- It is recommended to use a toilet with at least a 4.5 L ± 0.4 L flush volume.

A.3.4.2 Procedure

- Prior to adding any materials to the toilet bowl or initiating a flush, ensure that the toilet has stopped running and that the water in the bowl is at a normal level.
- When adding a product (e.g. hygienic wipe), place it in the center of the toilet bowl and allow sufficient time, typically 15 seconds, for it to become fully saturated with water before adding another product or flushing the toilet.
- No more than 2 wipes should be flushed at one time.
- Retrieve the products before they enter the basket or as soon as practically possible to prevent any disintegration by water flowing out of the pipe.
- When necessary, use additional flushes without the product to move it out of the drain line for collection.

A.3.5 Alternative Method

A.3.5.1 Equipment

- containers with a capacity of approximately 20 L (e.g. 5-gallon plastic buckets)

A.3.5.2 Procedure

- Fill the containers with tap water.
- Submerge the specimens in the water and swirl them for approximately 30 seconds or longer if necessary to remove any perceptible lotion or additives.
- To maintain the ratio of water to product existing in the toilet and drain line above, no more than 6 specimens should be placed together at one time in a single container with 20 L of tap water.

Annex 4 - Sieving and Recovery of Product Residues

(Informative)

A.4.1 Introduction

This annex describes the sieving, rinsing and recovery of product residues from the various disintegration tests. Once the samples are transferred to a sieve in these tests, these procedures are then used to rinse any small materials through the sieve and recover the residue for gravimetric analysis.

A.4.2 Equipment

- Peerless shower head Model 76114WH with hose assembly (pictured at right), or similar, attached to a faucet (tap) with a graduated flow regulator adjusted to deliver 4L per minute
- 4 L beaker (recommended)
- stopwatch or other timing device
- fine mesh hand sieve
- forceps
- drying pans

Source: IWSFG Member

A.4.3 Procedure

1. Turn on the faucet and adjust the regulator to a flow rate of 4 L per minute.

   OR:

   The flow rate can be determined by measuring the volume delivered to a suitable container with graduations after a specified time period. For example, it should take exactly 60 seconds to deliver 4 L of water to the 4 L mark on a beaker. Once the flow is adjusted, this measurement should be repeated at least three times and should vary less than 5%.
2. When transferring the contents from a disintegration test to the sieve, pour the contents of the test vessels slowly while distributing them over the complete surface of the sieve.
3. With the handheld showerhead spray nozzle held approximately 10 to 15cm (4 to 6") above the top surface, gently rinse smaller materials through the sieve. Constantly move the spray over the entire surface without concentrating the spray on any specific areas. Do not force the passage of any material through the sieve.

4. After 1 minutes of rinsing, quantitatively recover all the retained materials from both sides of the sieve using forceps or by backwashing the material into a smaller sieve and then using forceps.
5. Transfer these materials into labeled drying pans or tared weigh boats to determine their dry weight (see Annex 5).

Example of a Flow Regulator and Shower Head Rinse Apparatus

Source: IWSFG Member

Annex 5 – Drying and Weighing of Products and Product Residues

(Informative)

A.5.1 Equipment

- oven capable of maintaining a constant temperature of between 40° and 103°C
- weighing dishes
- forceps
- desiccator
- analytical Balance (reads to 4 decimal places)
- specimens

A.5.2 Procedure

A.5.2.1 Loss of Mass Calculation Procedure

1. If there are residual fragments in the sieve at the end of any of the 5 tests, collect them using the procedures described in Annex 4 prior to determining their dry weight.
2. Set the oven to a temperature appropriate for the chemical and physical properties of the specimen – this is typically 103 °C.
3. Place the specimens to be analyzed in an oven-safe weighing dish or on a piece of foil.
4. In the case of difficult to handle specimen residues, it may be appropriate to place the residues in a pre-weighed (tared) aluminum weigh boats.

5. Dry the specimens in the oven for several hours or overnight.
6. Transfer the specimens from the oven to a desiccator and allow them to cool.
7. Weigh the specimens and record their weights.
8. Return the specimens to the oven for approximately 30 minutes and again allow them to cool in the desiccator and determine their weights.
9. Repeat this process as necessary until all the specimens reach constant weights.
10. Record the total weight of residuals from tests 1-5;
11. Calculate the loss of mass using the Loss of Mass worksheet set out in Annex A.5.4.

A.5.3.2 Initial Dry Mass Calculation Procedure

1. Select 10 specimens in accordance with Annex 3, section A.3.3.
2. Specimens with water soluble lotions or additives should be pre-rinsed using the procedures described in Annex 3 prior to determining their dry weight.
3. Set the oven to a temperature appropriate for the chemical and physical properties of the specimen – this is typically 103 °C.
4. Place the specimens to be analyzed in an oven-safe weighing dish or on a piece of foil.
5. In the case of difficult to handle specimen residues, it may be appropriate to place the residues in a pre-weighed (tared) aluminum weigh boats.
6. Dry the specimens in the oven for several hours or overnight.
7. Transfer the specimens from the oven to a desiccator and allow them to cool.
8. Weigh the specimens and record the weights.
9. Return the specimens to the oven for approximately 30 minutes and again allow them to cool in the desiccator and determine their weights.
10. Repeat this process as necessary until the specimens reach constant weights.
11. Record the total weight of the five (5) specimens.
12. Calculate the loss of mass using the Loss of Mass Calculation Worksheet set out in A.5.4.

A.5.4 Example of a Loss of Mass Calculation Worksheet

Loss of Mass Calculation Worksheet				
Sample Number	**Initial Total Dry Mass of 5 Specimens Prepared in Accordance with Annex 4**	**Dry Mass of Retained Specimens from the 6.3 mm Sieve for Test 1 - 5**	**Percent Disintegration**	**95% Mass Loss PASS/FAIL**
1				