International Wastewater Services Flushability Group

IWSFG Standard - PAS 5B: 2017 – Anaerobic Biodisintegration Test

PUBLIC COMMENT VERSION

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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 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 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.

1 Introduction

Wastewater process systems are designed to receive, treat, and convey sanitary discharges1 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 a landfill site

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, facial tissues are commonly but inappropriately flushed. The physically adverse effects of the introduction 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 truly be considered as ‘flushable’ By adhering to these test methods and providing appropriate advice to the product users regarding the after use disposal of such products will ultimately lead to 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 clearly and prominently identify those products that do not meet the established IWSFG standards as being not “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 potential for a product to biodisintegrate when it is subjected to those environmental conditions typically found in anaerobic digesters at wastewater treatment plant facilities.

3 Scope

The scope of this PAS includes all products that a manufacturer or distributer may wish to identify as 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 – Sources of Apparatus
Annex 2 - Procedure for Pre-rinsing Test Products for Determining Initial Dry Mass
Annex 3 - Sieving and Recovery of Product Residues
Annex 4 - Drying and Weighing of Products and Product Residues
Annex 5 - Dry Mass Calculation Worksheet

5 Terms and Definitions

With the exception of the definition of Unit Size, see: IWSFG PAS 0:2017 *Terms and Definitions for Determination of Flushability*

5.1 Unit Size – dry tissues

The unit size for dry tissues is one tissue as removed from the packaging.

5.2 Unit Size – toilet paper

The unit size for toilet paper is one tissue removed from the center of the roll of toilet paper.

5.3 Unit Size – moist tissues

The unit dose for moist tissues is one tissue taken directly from the center of the packaging.

5.4 Unit Dose – other products

The unit dose for other products is one product taken directly from the packaging.

6 Principles

This test is used to demonstrate a product's potential to biodisintegrate when subjected to anaerobic conditions similar to those found in digesters in the majority of wastewater treatment plants around the world.

7 Apparatus

The items required for the test method are:

a. incubator controlled to 35 °C plus or minus 3 °C with a capacity to hold 3 or more 2 L flasks
b. an intrinsically safe incubator vented to prevent fires or explosions
c. 2 L tempered glass, wide-mouth, triple-baffled flasks
d. flask clamps
e. one hole butyl rubber plugs for the 2 L flasks
f. plastic tubing
g. 600 micron sieve greater than 18 cm in diameter

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

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

8.2 Number of test pieces

Three specimens are required for each complete testing.[2] Specimens should be obtained from at least two distinct packages of a product. To obtain three specimens, a roll of toilet paper, or a bundle of moist tissues in its original package should be divided into 3 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 glue effect.

To obtain moist tissue specimens, it will be convenient to turn their packaging on its side to see the whole bundle of moist tissues. Then, package will be divided into 3 equal sections, and a specimen will be removed from each part.

Caution is necessary not to damage delicate specimens when removing from the package. Specimens must be removed immediately before testing starts.

[2] Note: in order to prepare for the possibility that additional dry weight test verification is needed, 3 additional specimens should be acquired.

8.3 Sample preparation

The following requirements apply to products to be tested.

8.3.1 Dry tissues:

The sample shall comprise one unit of toilet paper or dry facial tissue.

8.3.2 Moist tissues

The sample shall comprise one unit of moist tissue taken directly from the packaging in accordance with sections 8.1 and 8.2.

8.3.3 Other products

The sample shall be one unit of other products taken directly from the package. If the specimen is large and thereby cannot be inserted into the flask, 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.

8.3.4 Test mixture

Liquid wastewater from an anaerobic digester of a municipal wastewater treatment plant, with primarily domestic sewage, shall be the source of the test mixtures. The liquid anaerobic sludge shall have the following characteristics:

1. range between 0.8 and 1% total solids
2. TSS (total suspended solids) between 2000 and 4000 mg/L
3. pH level between 6 and 9
4. anaerobic sludge from digester held no more than 48 hours and passed through a 600 micron sieve to remove large particulate
5. sludge with minimized contact with air

8.4 Apparatus

The incubator should be verified as operating at 35 °C plus or minus 3 °C.

9 Storage and Conditioning

9.1 Storage of samples

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

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 packages, e.g., hard-plastic containers or soft-plastic packages;
3. In case of hard-plastic containers, 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 while squeezing air out of the package, and then should be double-bagged with resealable plastic bags to minimize the potential exposure to the ambient air.
5. Samples shall be stored in secured laboratory cabinets.

9.2 Conditioning for the test

For non-moist products, there are no conditioning requirements. The test specimens should be removed from their packagings (if any) and used directly in the test procedure.

For moist products, i.e., those with lotions, they shall be gently agitated for 30 seconds in water to remove the moistening lotion.

10 Procedure

10.1 Summary

The test consists of the exposure of three specimens to warm conditions over 21 days, using specimens meeting the conditions set out in Section 8. After 21 days, observations are made regarding whether the specimen has biodisintegrated to the degree set.

10.2 Test procedure

The following procedures and conditions shall be followed:

1. Duplicate control cotton specimens should be used and one blank with only digester sludge to ensure an active biomass is being used.
2. The positive control specimen of cotton of should have a dry mass 2 grams. The control should be wetted with tap water prior to putting into the flask.

3. All flasks should be marked with sample date, identification of the sample, date put in the incubator and unique lab number.
4. If a purged glove box is not used, then each sample flask should be prepared individually to minimize oxygen contact.
5. Add the wetted specimen to the 1.5 L of anaerobic sludge to each flask.
6. Place a one holed stopper in the flask mouth and mix the test sample by swirling the flask or carefully flipping the container over with the one hole stopper sealed.
7. If gas pressure is generated during flipping, then carefully release the pressure while pointing away from people and equipment.
8. Place the flasks in the incubator and maintain a temperature of 35 °C for 21 days.
9. Check the sample flask periodically to ensure bubbling is occurring. If the samples are not generating gas, then the biomass may not be active and the test sample may need to be repeated.

At the end of 21-day test period:

10. Remove the sample flasks from the shaker table.
11. Transfer the entire contents in each flask individually through a 600-micron sieve.
12. Take photographs of upper and lower part of the sieve.
13. Rinse the residue trapped on the 600 micron sieve with tap water at a flow rate of 4 L/min for 1 minute.
14. Take photographs of the upper and lower surfaces of the sieve.
    a. If there are no residuals remaining on the sieve, the test is complete and the product has passed.
    b. If there are residuals remaining both 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 3). Transfer these materials into labeled drying pans or tared weigh boats to determine their dry weight (See Annex 4).
15. Take a photograph of all sieves.

10.3 Test Termination

Upon completion of a round of testing, the flasks shall be drained of any residue from the specimens and cleaned prior to testing another sample.

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

10.4 Calculations

The following calculations are required:

a. For Section 10.2.14 a:
Record the percentage of the three tests in which the biodisintegrated specimens passed through the 600 micron sieve.

b. For Section 10.2.14 b:
Record the percentage of each article's mass that disintegrated (operationally defined by the ability to pass through the 600 microns 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, 5 and 6.)

11 Acceptance Criteria

To be acceptable:

a. The biodisintegrated specimen residues of all three flasks must all pass completely through the 600 micron sieve.

OR:

b. If there is material left on the 600 micron sieve (after the 1 minute rinse), the percent of the starting dry mass (as computed in Step b of Section 10.4) passing through the 600 micron sieve must be greater than 95%. This result must be supported with visual examination and pictures of solids on the sieve.

12 Test Report

The test report should include the following information:

1. a reference to this test procedure
2. an overview of the test procedure
3. date and location of testing
4. 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. original dimensions and weight of the product
7. any departure from the procedure and any circumstances that may have affected the results along with an explanation
8. copies of photographs taken during the procedure
9. the test results, including:
    a. The number of tests in which the biodisintegrated specimens, if any, did not pass through the sieve
    b. photographs of the upper and lower surfaces of the sieves
    c. the percentage of dry mass which passed through the 600 microns sieve after 1 minute of rinsing
    d. A final statement indicating whether the product passed or failed the test

13 Precision

Depending on the chemicals used in the product binder and lotions, their dissolution in water may vary, which could affect the degree of biodisintegration achieved.

Check the sample flask periodically to ensure that bubbling is occurring. Log in the length of time during which the samples are not generating gas. Note any differences in the control samples.

There may be some variation in the quality of the products being tested, which is why 3 separate specimens shall be acquired, according to Sections 8.1 and 8.2.

Bibliography

1. *FG505A Aerobic Biodisintegration Test, Guidelines for Assessing the Flushability of Disposable Nonwoven Products*, INDA, 2013.

2. *Test Protocol to Determine the Flushability of Disposable Products*, WRc PLC. Swindon, Frankland Road, Blagrove,Swindon, Wiltshire, SN5 8YF. Collaboration Project CP: 311. Report No.:P7696, March 2008. Drinkwater,Andy and Stefania Galletti.

3. *Wastewater Biology: The life processes*, Water Environment Federation, 1994

4. *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 1015 15th Street, Washington, DC, 20005, USA. [www.apha.org].

Annex 1 – Sources of Apparatus

(Informative)

The equipment required for this test can be purchased at most laboratory supply vendors and the basic equipment can also be purchased at local hardware retail outlets.

Annex 2 - Procedure for Pre-rinsing Test Products for Determining Initial Dry Mass

(Informative)

A.2.1 Introduction

This Annex describes two approaches to pre-rinsing test products to remove water soluble lotions or other additives from products before using them in the determination of their 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 is not available, an alternative method can be used that involves swirling products in a container of tap water.

A.2.2 Test Product Selection

- When conducting a test to support a flushability 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 moist tissues, which occur in a roll or stack.

A.2.3 Toilet and Drain Line Method

A.2.3.1 Equipment

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

A.2.3.2 Procedure

- Prior to adding any materials to the toilet bowl or initiating a flush, ensure that the toilet has stopped running and 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 moist tissues 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 products out of the drain line for collection.

A.2.4 Alternative Method

A.2.4.1 Equipment

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

A.2.4.2 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 3 specimens should be placed together at one time in a single container with 20 L of tap water.

Annex 3 - Sieving and Recovery of Product Residues

(Informative)

A.3.1 Introduction

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

A.3.2 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.3.3 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 entire surface of the sieve;
3. With the handheld showerhead spray nozzle held approximately 10 to15cm (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 4).

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Example of a Flow Regulator and Shower Head Rinse Apparatus

488 Source: IWSFG Member

Annex 4 – Drying and Weighing of Products and Product Residues

(Informative)

A.4.1 Equipment

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

A.4.2 Procedure

A.4.2.1 Loss of Mass Calculation Procedure

1. If there are residual fragments at the end of any of the 3 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 weight.
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 the specimens reach constant weights.
10. Calculate the loss of mass using the Loss of Mass Worksheet set out in Annex 5.

A.4.3.2 Initial Dry Mass Calculation Procedure

1. Select 3 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 weight.

9. Return the specimens to the oven for approximately 30 minutes and again allow them to cool in the desiccator and determine their weight.
10. Repeat this process as necessary until the specimens reach constant weights.
11. Calculate the loss of mass using the Loss of Mass Worksheet set out in Annex 5.

Annex 5 – Drying and Weighing of Products and Product Residues

(Informative)

A.5.1 Equipment

- oven capable of maintaining a constant temperature 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 at the end of any of the 3 tests, collect them using the procedures described in Annex 3 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 boat.
5. Try 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 the weight.
8. Return the specimens to the oven for approximately 30 minutes and again allow them to cool in the desiccator and determine their weight.
9. Repeat this process as necessary until the specimens reach constant weights.
10. Calculate the loss of mass using the loss of Mass worksheet set out in Annex 4.4.

A.4.3.2 Initial Dry Mass Calculation Procedure

1. Select 3 specimens in accordance with Annex 2 section A.2.3

2. Specimens with water soluble lotions or additives should be pre-rinsed using the procedures described in Annex 2 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 weigh.
9. Return the specimens to the oven for approximately 30 minutes and again allow them to cool in the desiccator and determine their weight.
10. Repeat this process as necessary until the specimens reach constant weights.
11. Calculate the loss of mass using the loss of Mass worksheet set out in Annex 4.4.

A.4.4 Example of a Loss of Mass Calculation Worksheet

Loss of Mass Calculation Worksheet				
Sample Number	**Initial Total Dry Mass of 3 Specimens Prepared in Accordance with Annex 4**	**Dry Mass of Retained Specimens from the 600 micron Sieve,**	**Percent Disintegration**	**95% Mass Loss PASS/FAIL**
1				

CALCULATION (Initial dry weight of sample – retained dry weight)/Initial dry weight *100