# Method to determine particle size distribution of compost and its physical contaminant and stone contents

## 1.0 Scope

The test procedures instructed in this document are for air-drying of a sample of compost followed by determination of its particle size distribution, physical contaminants and moisture content after air-drying. See 4.0 'Principle' for a more detailed description.

## 2.0 Normative references

ISO 565, Test sieves - Metal wire cloth, perforated metal plate and electroformed sheet - Nominal sizes of openings
*http://www.iso.org/iso/catalogue_detail.htm?csnumber=4656*

BS EN 12579, Soil improvers and growing media. Sampling
*http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030006469*

BS EN 13040, Soil improvers and growing media. Sample preparation for chemical and physical tests, determination of dry matter content, moisture content and laboratory compacted bulk density
*http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030116945*

PAS 100:2011, Publicly Available Specification for composted materials, British Standards Institution, January 2011.

*NOTE Where a normative reference does not include a date of publication (e.g. year), use the latest edition published.*

## 3.0 Terms and definitions

*NOTE For definition of composted material, see 3.2 'composting' and 3.1 'compost'.*

### 3.1 compost

solid particulate material that is the result of composting, that has been sanitized and stabilized and that confers beneficial effects when added to soil, used as a component of a growing medium, or is used in another way in conjunction with plants

### 3.2 composting

process of controlled biological decomposition of biodegradable materials under managed conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat

### 3.3 other non-stone physical contaminants

paper, cardboard and any man-made materials other than glass, metal and plastic, which are > 2 mm in any dimension

### 3.4 physical contaminants

glass, metal, plastic, and 'other non-stone physical contaminants' greater than 2 mm in any dimension

### 3.5 sharps

man-made contaminants greater than 2 mm in any dimension that can cause physical injury to a person or animal who comes into contact with these materials, including a person who handles composted materials without protective gloves

*NOTE This is the definition of 'sharps' used in PAS 100:2011. Organic components such as twigs, woody fragments and bones (whole or in part) can puncture skin, as too can rock-derived 'mineral' particles and aggregated particles of all sizes, including for example gravel and stones. However, the risk that any such particle punctures skin is considered acceptably low in the context of compost use, so particles of these kinds were omitted from the definition.*

### 3.6 stones

extraneous, hard mineral matter greater than 4 mm in any dimension

*NOTE Does not include glass, plastic or metal, but does include pebbles and pieces of aggregate, concrete, tile, rubble, pottery and any other consolidated mineral particles greater than 4 mm in any dimension.*

### 3.7 test sample

sample prepared from the laboratory sample and on which the tests instructed in this document are carried out

## 4.0 Principle

The sample of compost is air-dried (to ≤ 15 % moisture content mass/mass 'air-dry' sample) at a temperature not exceeding 40 °C and then sieved with a specified nest of sieves using a mechanical sieving machine. The mass fraction distribution of particle sizes is determined and reported, as too are the sample's physical contaminant contents > 2 mm and, separately, its content of stones > 4 mm. 'Sharps' > 2 mm are a sub-category of physical contaminants, which are determined and reported. Plain and non-plain paper and cardboard particles > 2 mm are determined and reported as a sub-category of physical contaminants.

The procedures described herein apply only to those samples that are supplied to the laboratory in the form in which they shall be used for their intended purpose, or as supplied as a product ingredient.

***N.B.:*** *The samples used for optimizing the sieving-shaking machine settings and the test sample are <u>not</u> oven-dried. Therefore, the test results and physical contaminant limits in PAS 100 are expressed as % mass/mass of the 'air-dry' sample, which is neither a fresh mass 'as received', nor 'dry mass' basis.*

If a laboratory approved by the Association for Organics Recycling (AfOR) deviates from any instruction in this method of test, documented evidence of equivalent effect(s) / result(s) shall be supplied to AfOR for evaluation of suitability.

## 5.0 Apparatus

5.1 *Balance*, weighing range at least 4 kg, accuracy 0.1 g.

5.2 *Drying facilities*, at a temperature not exceeding 40 °C.

*NOTE Equipment such as a forced draft drying oven or drying room with good air circulation and means of moisture removal (e.g. de-humidifier) may be used.*

5.3 *Drying tray*, rim height approximately 5 cm, minimum bottom area 400 $cm^2$, heat proof to approximately 50 °C.

5.4 *Electromagnetic sieving-shaking machine*, vertical vibrating movement, with amplitude adjustment and interval timer. Standard setting: 7 min, interval every 10 s, 1 s rest, amplitude approximately 1 mm to be optimized for each separate machine.

5.5 *Optimization sample*, compost (that undergoes air-drying and is then used for optimizing sieving-shaking machine settings), particles < 16.0 mm, of which 0 mm to 8 mm fraction between 10 % m/m and 40 % m/m.

5.6 *Sieves*, diameter 200 mm or 300 mm, rim height 55 mm, aperture sizes as listed in ISO 565, stainless steel woven wire test sieve set (apertures 31.5 mm, 16.0 mm, 8.0 mm, 4.0 mm, 2.0 mm, 1.0 mm), with *reception tray* (pan) and *sieve lid*.

5.7 *Test sample*, compost (that undergoes air-drying followed by determination of its particle size distribution and physical contaminant - including sharps - and stone contents).

*NOTE to 5.6 and 5.7 If the compost test sample has been graded using screen apertures 20 mm or less, the 31.5 mm sieve may be omitted if a sieve of aperture 20 mm or smaller is used during the laboratory test. For example, a composter who supplies a compost grade used as or in growing media may request that a sieve with 12 mm apertures is added to set of sieves used and the sieve with 31.5 mm apertures is omitted.*

5.8 *Tray*, rim height approximately 10 cm, contents approximately 1.5 l.

## 6.0 Optimization of the sieving-shaking machine

### 6.1 General

Prior to its first use the sieving-shaking machine shall be optimized as instructed in 6.2 to 6.5 below. Optimization shall be carried out at least once per year.

### 6.2 Obtaining a sample of compost material suitable for optimization of the sieving-shaking machine

Sieve the optimization sample (5.5) through 31.5 mm and 16.0 mm aperture sieves (5.6) collecting not less than 1.5 litres (of particles that have passed through these sieves) per tray (5.8). Determine the moisture content of the sieved optimization sample in accordance with BS EN 13040. Take a representative sub-sample of the sieved optimization sample (for 300 mm sieve take 500 ml, for 200 mm sieve take 250 ml) weigh and air-dry it in the drying facility (5.2) for 24 h. Weigh the air-dry optimization

sample; if its moisture content exceeds 15 % m/m dry it until its moisture content is ≤ 15 % m/m.

Place sieves (apertures 8.0 mm, 4.0 mm, 2.0 mm and 1.0 mm) and the reception tray on the sieving-shaking machine (5.4); the reception tray placed at the bottom and the sieves placed on top in order of ascending aperture size (the sieve with the largest apertures at the top). Distribute the sieved and air-dry optimization sample evenly on the uppermost sieve (apertures 8.0 mm). Place the lid on the uppermost sieve and secure the sieves and reception tray to the sieving machine. Switch on the sieving-shaking machine for 7 min at maximum amplitude.

After 7 min, when the sieving-shaking machine has come to rest, remove the reception tray and sieves from it and determine the mass fractions for each 'sieve plus portion of optimization sample retained on it' and the 'reception tray plus portion of optimization sample retained on it'.

Dry clean the sieves and the reception tray. Determine the empty masses of the sieves and reception tray.

Calculate the sieved optimization sample's fraction distribution in accordance with 6.5.1. If between 10 % m/m and 40 % m/m of the sieved optimization sample is in the 0 mm to 8 mm particle size range continue the optimization procedure (6.3) with the same optimization sample material.

### 6.3 Optimization of the sieving-shaking machine

Divide the calibration of the amplitude in 10 equal steps. Manually sieve (16.0 mm apertures) sufficient optimization sample to obtain 30 sub-samples of 500 ml each so they do not contain particles greater than 16 mm. Put each of these sub-samples on a drying tray (5.3) and spread evenly over its area. Air-dry (7.3) the sub-samples until their moisture content does not exceed 15 % m/m of their total mass. Determine their residual moisture content in accordance with BS EN 13040.

Assemble the sieves in ascending order of aperture size on top of the reception tray on the sieving-shaking machine. For each amplitude setting, carry out the procedures instructed in the two paragraphs below.

Spread 3 of the air-dry optimization sub-samples on the uppermost sieve, place the lid on that sieve, fix the sieves on the sieving-shaking machine then switch it on for 7 min at the chosen amplitude setting.

After the sieving-shaking machine has been turned off and come to rest, determine the mass per 'sieve plus portion of optimization sub-sample retained on it' and mass of the 'reception tray plus portion of optimization sub-sample retained on it'. When the three optimization sub-samples have been sieved and weighed in this way, dry clean the sieves and the reception tray then determine and record the empty mass of each. Calculate the fraction distribution using the calculation given in 6.5.2.

### 6.4 Determining the optimum amplitude setting

For all values obtained, round off each to the nearest 5 % of sieved optimization sample that has fallen within the 0 mm to 1 mm particle size category. Determine at which

setting the rounded-off value for the fraction 0 mm to 1 mm is greatest; use this setting as the standard setting. If more than one setting gives the greatest fraction 0 mm to 1 mm, use the lowest amplitude setting as the standard setting.

### 6.5 Calculations

#### 6.5.1 Calculation of fraction distribution during assessment of sample suitability for optimization of the sieving-shaking machine

Calculate the mass of the 0 mm to 8.0 mm sample fractions as a percentage of the sum of the total mass of the sample, in accordance with Equation 1. (These fractions are those resting on the 1.0 to 8.0 mm aperture sieves plus the fraction in the reception tray.)

**Equation 1.**

$$\text{Sieved sample fractions 0 mm to 8 mm} = \frac{B}{A + B} \times 100$$

Where:

A = (mass of reception tray plus sample) - (mass empty reception tray);

B = (mass sieve 8.0 mm plus sample) - (mass empty sieve 8.0 mm).

Express calculated result as '% m/m'.

#### 6.5.2 Calculations of fraction distribution of a sample

Calculate the mass of the relevant fraction(s) as a percentage of the total mass of the sample, in accordance with Equation 2.

**Equation 2.**

$$\text{Sieved sample fraction Z (1....7)} = \frac{A\,(1....7)}{Ai} \times 100$$

Where:

$A_{1...7}$ = (mass of sieve plus sample) - (mass of empty sieve);

$A_i = A_1 + A_2 + A_3 + A_4 + A_5 + A_6 + A_{7;}$

$_1$ = sieve 31.5 mm, $_2$ = sieve 16 mm, $_3$ = sieve 8 mm, $_4$ = sieve 4 mm,
$_5$ = sieve 2 mm, $_6$ = sieve 1 mm, $_7$ = reception tray

For each fraction determine the average and round it off to 0.01 % accuracy.

Express each calculated result as '% m/m'.

## 7.0 Test sample preparation

### 7.1 General

For the determination of particle size distribution and physical contaminants, compost shall be sampled in accordance with BS EN 12579.

Prepare the test sample in accordance with BS EN 13040:2000, clauses **6**, **7**, and **8.1**.

### 7.2 Air-drying of test sample and moisture content check

Take a representative volume of the sample, as received, and place it into one or more drying trays (5.3). The volume of the sample taken shall not be less **than 1.125 litres** (see note 1).

Spread the sample over the surface of the tray(s) as uniformly as possible, weigh and record its mass (in g). Place the loaded tray(s) in the drying facility (5.2) and air-dry the sample until its moisture content does not exceed 15 % m/m of its total mass. After cooling, weigh and record the mass (in g) of the air-dry sample with its tray. Weigh and record the mass (in g) of each tray.

*Note 1: Normally a volume between 1.125 and 2.25 litres is used, depending on the sample's particle size distribution. E.g. a smaller volume of compost with a high proportion of fine particles may be required than the volume needed when testing a compost with a high proportion of coarse particles.*

*Note 2: Air-drying the sample at 40 ºC until its moisture content does not exceed 15 % m/m should take between 16 and 24 hours.*

### 7.3 Moisture content of air-dry test sample

After air-drying the test sample determine its moisture content in accordance with BS EN 13040. Express the result as % m/m 'air-dry sample'.

## 8.0 Procedures for determining particle size distribution and physical contaminants content of the air-dry sample

### 8.1 Particle size distribution

Carry out the determination of the particle size distribution within 24 h after air-drying of the test sample has been completed (7.2.1). Until sieving is undertaken, store the air-dry test sample in conditions that will not allow its moisture to exceed 15 % m/m. Changes in sample volume may occur if moisture is absorbed.

Assemble the sieves in ascending order of aperture size on top of the reception tray on the sieving machine. Distribute all three prepared sub-samples evenly on the upper sieve. Place the lid on the upper sieve and secure the sieves. Switch on the sieving machine for 7 min at standard setting. Determine the mass of each sieve and of the reception tray when loaded with the sieved sub-samples.

When all three sub-samples are thus sieved and weighed, determine the mass of each sieve and the reception tray when empty after being dry-cleaned. Subtract the mass of each sieve and reception tray when empty from each of their masses when loaded (as described in 6.5.2). Calculate each sample fraction mass. For each sample fraction, subtract the total mass of physical contaminants (8.1.2) in the fraction then calculate the compost's fraction mass.

### 8.2. Physical contaminants

From the sample retained on each sieve with apertures 2 mm or larger, pick over and remove physical contaminants (3.4): glass, metal, plastic, and 'other non-stone physical contaminants' > 2 mm in any dimension. Paper, cardboard and any man-made materials other than glass, metal and plastic, and which are > 2 mm in any dimension shall be counted as 'other non-stone physical contaminants' (see 3.3 for definition and report item 9.1 k) and l)).

From the sample retained on each sieve with apertures 2 mm or larger, pick over and remove any 'stone and other consolidated mineral' (e.g. masonry, concrete, tile and rubble) fragments > 4 mm in any dimension (3.6).

Any woody particles that fall on their end through any sieve aperture shall be weighed and recorded as compost (9.1), on the sieve upon which they rest after sieving (8.1).

From the contents of each sieve with apertures 2 mm or larger, sort any physical contaminant(s) into a discrete pile for each physical contaminant type. For each size fraction of sieved test sample > 2 mm, weigh and record the total mass of each physical contaminant type. Calculate the total mass of each type of physical contaminant in the sieved test sample fraction > 2 mm.

Then, for each size fraction of physical contaminants, sort from the discrete piles of glass, metal, plastic and 'other non-stone fragments' any fragments deemed 'sharp' (3.5) by the person carrying out the test. Weigh and record the total mass of any such 'sharps' in each size fraction. Calculate the total mass of 'sharps' in the test sample fraction > 2 mm. 'Sharps' shall be reported separately from each size fraction of physical contaminants and total physical contaminants (see section 9.1, particularly o) and p)).

## 9.0 Report of test results

### 9.1 Expression of results

Record and report the following as 2 decimal place numbers or percentages (unit as specified below):

a) aperture size of each sieve used (mm, to 1 d.p.);

b) representative volume of the sample subject to the procedures described in 7.2 (litres, to 3 d.p.)

c) moisture content of the air-dry test sample (% m/m, to 1 d.p.);

d) the total mass of air-dry test sample (compost, physical contaminants and stones) from all sieves and the reception tray (g, to 2 d.p.);

e) the mass of air-dry test sample (compost, physical contaminants and stones) from each sieve (g, to 2 d.p.);

f) the mass of air-dry test sample (compost, physical contaminants and stones) from the reception tray (g, to 2 d.p.);

g) the total mass of compost, from all sieves and the reception tray (g, to 2 d.p.);

h) the mass of compost, from each sieve (g, to 2 d.p.);

i) the mass of compost, from the reception tray (g, to 2 d.p.);

j) the % m/m compost, retained on each sieve in the set used and on the reception tray (g, to 2 d.p.);

k) the cumulative % m/m compost, that retained on each sieve in the set used and on the reception tray (g, to 2 d.p.);

l) the total mass of each of the physical contaminant types (glass, metal, plastic, and 'other non-stone' whether or not any such fragments are 'sharp') on each sieve for particles ≥ 2 mm (g, to 2 d.p.);

m) the total mass of all physical contaminant types (glass, metal, plastic, and 'other non-stone' whether or not any such fragments are 'sharp') from all sieves with ≥ 2 mm apertures (g, to 2 d.p.);

n) the total mass of stone(s) and other consolidated mineral contaminants on each sieve for those fragments ≥ 4 mm (g, to 2 d.p.);

o) the total mass of stone(s) and other consolidated mineral contaminants from all sieves with ≥ 4 mm apertures (g, to 2 d.p.);

p) the total mass of 'sharps' on each sieve with ≥ 2 mm apertures (g, to 2 d.p.);

q) the total mass of 'sharps' from all sieves with ≥ 2 mm apertures (g, to 2 d.p.);

*NOTE See Annex 1 for an example report template.*

### 9.2 Other information

The report of air-dry test sample results shall include the following information:

a) a reference to this method;

b) compost sample identification; and

c) any additional factors which may have affected the results.

*NOTE See Annex 1 for an example report template, also with upper limits as applicable in PAS 100:2011 for physical contaminants and stones and reference to the composter's quality policy in terms of 'sharps'.*

## Annex 1. Example report template

< Customer name >
< Company name >
< Company address line 1 >
< Company address line 2 >
< Company address line 3 >
< Company address line 4 >
< Company postcode >

< Lab name >
< Lab address line 1 >
< Lab address line 2 >
< Lab address line 3 >
< Lab postcode >
< Lab VAT Reg. No. >
< Lab contact person's name >

**ANALYSIS REPORT ~ COMPOSTED MATERIAL**
Laboratory approved by the Association for Organics Recycling

| **Customer information** | | **Laboratory information** | |
|---|---|---|---|
| Composting site | < name > | Received at lab | < date > |
| Grade (particle size range) | < ? mm to ? mm > | Lab sample number | < number > |
| Grade type | < Principal or Additional > | Lab batch number | < number > |
| Certification code | < certification code > | Lab report code | < code > |
| Date sampled | < date > | Report by | < name > |
| Batch age when sampled | < age > | Report date & time | < date&time > |
| Producer's sample code | < producer's sample code > | Report number | < number > |

**PARTICLE SIZE DISTRIBUTION (air-dry sample)**

| **Sieve apertures** | **Sample** | **of which Compos** | **Cumulative** | | **Method** |
|---|---|---|---|---|---|
| | Retained | Retained | Retained | Passing | **Reference** |
| mm | g | g | % | % | |
| 31.5 | 0.0 | 0.0 | 0.0 | 100.0 | AfOR MT |
| 16.0 | 6.7 | 6.7 | 1.7 | 98.3 | PC&S [1] |
| 12.0 | 0.0 | 7.7 | 3.6 | 96.4 | |
| 8.0 | 26.7 | 16.5 | 7.7 | 92.3 | |
| 4.0 | 97.0 | 78.8 | 27.2 | 72.8 | |
| 2.0 | 117.7 | 107.6 | 53.9 | 46.1 | |
| 1.0 | 107.5 | 107.5 | 80.6 | 19.4 | |
| Pan | 78.0 | 78.0 | 100.0 | 0.0 | |
| **Total** | **433.6** | **402.8** | | | |

[1] State whether with modification, i.e. apertures of any sieves added or omitted.
ND = Not Determined, N/A = Not Applicable

Annex 1. Example report template (continued)

< Customer name >
< Company name >
< Company address line 1 >
< Company address line 2 >
< Company address line 3 >
< Company address line 4 >
< Company postcode >

< Lab name >
< Lab address line 1 >
< Lab address line 2 >
< Lab address line 3 >
< Lab postcode >
< Lab VAT Reg. No. >
< Lab contact person's name >

**ANALYSIS REPORT ~ COMPOSTED MATERIAL**

Laboratory approved by the Association for Organics Recycling

| **Customer information** | | **Laboratory information** | |
|---|---|---|---|
| Composting site | < name > | Received at lab | < date > |
| Grade (particle size range) | < ? mm to ? mm > | Lab sample number | < number > |
| Grade type | < Principal or Additional > | Lab batch number | < number > |
| Certification code | < certification code > | Lab report code | < code > |
| Date sampled | < date > | Report by | < name > |
| Batch age when sampled | < age > | Report date & time | < date&time > |
| Producer's sample code | < producer's sample code > | Report number | < number > |

**PHYSICAL CONTAMINANTS (air-dry sample)**

| **Sieve apertures** [1] | **Glass** | **Metal** | **Plastic** | **Other** [2] | **Description** | **Total** [3] | **of which** | **Stones** [5] | **Method Reference** |
|---|---|---|---|---|---|---|---|---|---|
| mm | g | g | g | g | | g | g | g | |
| 31.5 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 0.00 | AfOR MT |
| 16.0 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 | 1.50 | PC&S [1] |
| 8.0 | 0.00 | 0.00 | 0.20 | 0.40 | | 0.60 | 0.00 | 14.00 | |
| 4.0 | 0.00 | 0.15 | 0.00 | 0.00 | | 0.15 | 0.00 | 18.24 | |
| 2.0 | 0.80 | 0.00 | 0.00 | 0.00 | | 0.80 | 0.40 | 10.10 | |
| 1.0 | ND | ND | ND | ND | N/A | ND | ND | ND | |
| Pan | ND | ND | ND | ND | N/A | ND | ND | ND | |
| **% of total sample > 2 mm** | **0.18** | **0.03** | **0.05** | **0.09** | | **0.36** | **0.09** | N/A | |
| **% of total sample > 4 mm** | N/A | N/A | N/A | N/A | | N/A | N/A | **7.78** | |
| PAS 100 upper limit for "mulch" | | | **0.12** | | | **0.25** | R | **10.0** | |
| **Pass or Fail** | | | **Pass** | | | **Fail** | R | **Pass** | |
| limit for other than "mulch" | | | **0.12** | | | **0.25** | R | **8.0** | |
| **Pass or Fail** | | | **Pass** | | | **Fail** | R | **Pass** | |

[1] State whether with modification, i.e. apertures of any sieves added or omitted

[2] Any different physical contaminant type; name in 'Description'

[3] 'Total' is for glass, metal, plastic and 'other'. N.B.: excludes stones

Annex 1. Example report template (continued)

[4] Sharps > 2 mm, of any inorganic physical contaminant type (excludes woody fragments)

[5] Stones and other consolidated mineral contaminants

[R] Refer to composter's quality policy for upper limit allocated to the compost grade and intended market / end use, and evaluate sharps result against that limit.

ND = Not Determined, N/A = Not Applicable