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Characterization of waste — Test methods for the determination of the monolithic status of waste

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The UK participation in its preparation was entrusted to Technical Committee B/508/3, Characterization of waste.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Characterisation of waste - Test methods for the determination of the monolithic status of waste

Caractérisation des déchets - Vérification du caractère monolithique d'un déchet

Charakterisierung von Abfällen - Prüfverfahren für die Bestimmung der monolithischen Eigenschaften von Abfällen

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Foreword

This document (CEN/TS 16675:2014) has been prepared by Technical Committee CEN/TC 292 “Characterization of waste”, the secretariat of which is held by NEN.

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Introduction

Disposal of some types of waste requires stabilisation/solidification to reduce the impact and/or comply with regulatory requirements. The characterisation of waste is an essential step for the assessment of a potential final destination, especially in case of landfilling and associated potential hazards. Based on its properties, a stabilised/solidified waste material may be allocated to a landfill for granular waste or a landfill for monolithic waste. Information on certain physical properties of a given stabilised/solidified waste material is required to determine if it can be classified as a monolithic material and to select appropriate leaching test method(s) and landfilling options for that waste. This technical specification describes test methods applicable to assessment of these physical properties.

WARNING – Anyone dealing with waste and sludge analysis should be aware of the typical risks of that kind of material irrespective of the parameter to be determined. Waste and sludge samples may contain hazardous (e.g. toxic, reactive, flammable, infectious) substances, which can be liable to biological and/or chemical reaction. Consequently these samples should be handled with special care. Gases which may be produced by microbiological or chemical activity are potentially flammable and will pressurise sealed bottles. Bursting bottles are likely to result in hazardous shrapnel, dust and/or aerosol. National regulations should be followed with respect to all hazards associated with the methods in this technical specification.

1 Scope

This Technical Specification provides methods, which can be used to assess the monolithic character of a stabilised/solidified waste, with respect to landfilling. Information on the monolithic character is required to enable the choice of appropriate leaching tests for determination of the release of different substances from stabilised/solidified waste under specified (landfilling) conditions.

This document includes several physical and/or chemical test methods each addressing different aspects of monolithic character. The selection of methods required for an assessment of the monolithic character of a stabilised/solidified waste may vary, depending on the scenario to be addressed or it may be specified in regulation.

Rather than describing the procedures and methods in detail this document refers to existing standards and provides some guidance on their use on stabilised/solidified waste materials.

This Technical Specification does not address issues related to health and safety.

The following procedures and methods are included in this document:

— test to determine unconfined compressive strength;

— test to determine permeability;

— test to determine the loss of mass by dissolution or disintegration;

— test to determine expansion;

— test to determine the content of organic matter;

— test to determine freeze/thaw effects.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12390-3, *Testing hardened concrete - Part 3: Compressive strength of test specimens*

EN 13137, *Characterization of waste - Determination of total organic carbon (TOC) in waste, sludges and sediments*

EN 15002, *Characterization of waste - Preparation of test portions from the laboratory sample*

CEN/TR 15177:2006, *Testing the freeze-thaw resistance of concrete - Internal structural damage*

EN 15216, *Characterization of waste - Determination of total dissolved solids (TDS) in water and eluates*

CEN/TS 15863, *Characterisation of waste - Leaching behaviour test for basic characterisation - Dynamic monolithic leaching test with periodic leachant renewal, under fixed test conditions*

CEN/TS 15864, *Characterisation of waste - Leaching behaviour test for basic characterisation - Dynamic monolithic leaching test with continuous leachant renewal under conditions relevant for specified scenario(s)*

CEN ISO/TS 17892-11, *Geotechnical investigation and testing - Laboratory testing of soil - Part 11: Determination of permeability by constant and falling head (ISO/TS 17892-11)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
dry matter
wdm
mass fraction of a sample excluding water expressed as a percentage by mass calculated by determination of dry residue or water content

[SOURCE: EN 14346]

3.2
dry residue
***w*dr**
remaining mass fraction of a sample after a drying process at 105 °C

[SOURCE: EN 14346]

3.3
eluate
solution recovered from a leaching test

3.4
laboratory sample
sample or subsample (s) sent to or received by the laboratory

[SOURCE: IUPAC:1997]

Note 1 to entry: When the laboratory sample is further prepared (reduced) by subdividing, mixing, grinding or by combinations of these operations, the result is the *test sampl*e. When no preparation of the laboratory sample is required, the laboratory sample is the *test sampl*e. A *test portion* is removed from the *test sample* for the performance of the test or for analysis. The laboratory sample is the final sample from the point of view of sample collection but it is the initial sample from the point of view of the laboratory.

Note 2 to entry: Several laboratory samples could be prepared and sent to different laboratories or to the same laboratory for different purposes. When sent to the same laboratory, the set is generally considered as a single laboratory sample and is documented as a single sample.

3.5
leachant
liquid used in a leaching test

[SOURCE: EN 12457–1]

3.6
leaching test
test during which a material is put into contact with a leachant and some constituents of the material are extracted

[SOURCE: EN 12457–1]

3.7
monolithic waste
waste prepared with certain minimum dimensions and physical and mechanical properties that ensure its integrity over a certain period of time in the considered scenario

3.8
stabilised/solidified waste
waste stabilised/solidified by chemical and physical means to form a coherent body maintaining its integrity in the landfill over a specified timeframe.

3.9
test portion
quantity of material of proper size for measurement of the concentration or other properties of interest removed from the test sample

[SOURCE: IUPAC:1997]

3.10
test portion of monolithic waste
specimen obtained either by moulding, by cutting or by coring and ready for the performance of a leaching test with a minimum dimension in all directions of 40 mm

Note 1 to entry: The test portion could be taken from the laboratory sample directly if no preparation of sample is required, but usually it is taken from the prepared test sample.

3.11
test sample
sample, prepared from the laboratory sample, from which test portions are removed for testing or analysis

[SOURCE: IUPAC:1997]

3.12
water content
w**w**
mass fraction of water in a sample determined by Karl-Fischer-titration

[SOURCE: EN 14346]

3.13
waste monolith
waste delivered as bulky forms of specified minimum dimensions retaining its form in the landfill over a specified timeframe

Note 1 to entry: It may generally not be necessary to test a few waste monoliths disposed amongst granular waste, as their contribution to the landfill leachate quality will be marginal.

4 Principle

The selection of methods to be used to assess the monolithic character of a specific waste material provided in this document shall address the conditions imposed by the relevant landfill scenario(s). In general, there is an intention to produce a monolithic waste form which will maintain its integrity under specified conditions over a specified time span for the landfill. The following procedures allow assessment of the monolithic character of a waste sample of regular shape in order to enable selection of appropriate test methods and interpretation models for the determination of the release of substances from the waste under landfilling conditions. Some of the procedures may also be used to determine if the waste material fulfils applicable geotechnical requirements for landfilling. If for some reason one or more of the procedures are not considered necessary for a specific purpose, the justification for that shall be given in the test report.

5 Equipment and reagents

The equipment and reagents to be used are listed in the selected methods and procedures.

6 Sampling and sample preparation

EN 15002 provides general instructions on the preparation of test portions from a laboratory sample of monolithic waste.

Each of the selected test methods will, however, include specific requirements on sample preparation which shall be followed.

7 Procedures

7.1 General

One or more of the following procedures shall be used to assess the monolithic character of a stabilised/solidified waste material.

7.2 Unconfined compressive strength (UCS)

A monolithic material to be placed in a landfill shall have sufficient bearing capacity to support trucks and compacting equipment on the surface and sufficient strength to support its own mass. The waste in a landfill is usually enclosed in a confined space which has a stabilising effect on its physical stability, also in the longer term. The requirements on strength for monolithic waste to be landfilled will generally be substantially lower than those for monolithic waste forms to utilised, e.g. as bricks which are often used under unconfined conditions. Measurement of the unconfined compressive strength will allow an assessment of whether or not the bearing capacity of a monolithic waste material is sufficient in relation to a specific landfill scenario. The test may be carried out both before and after water exposure.

The following standard shall be used: EN 12390-3.

The results shall be reported in accordance with the requirements in the standard. For the purpose of assessment of the monolithic character of the waste material, the unconfined compressive strength (UCS) shall be reported in N/mm^2 (MPa).

7.3 Permeability

The mechanism by which substances are released from a monolithic waste material depends to a large extent on the pattern of the flow of water around or through the material. Under specified external conditions the flow pattern is dependent on the permeability of the monolithic waste. Measurement of the permeability of the monolithic waste material will therefore provide information on the potential flow under landfill conditions and hence contribute to an assessment of the monolithic character of the material.

The following standard shall be used: CEN ISO/TS 17892-11.

The results shall be reported in accordance with the requirements given in CEN ISO/TS 17892-11. For the purpose of assessment of the monolithic character of the waste material the water permeability shall be reported in m/s.

7.4 Loss of mass

If a monolithic material to be placed in a landfill loses a substantial part of its mass by dissolution in water passing through or around it, it is likely to settle or collapse and thereby develop cracks or lose its integrity. This will have an influence both on the physical stability of the landfilled material and the release of substances. Determination of the loss of mass by dissolution of solids will provide an indication of the risk that this will occur and hence contribute to the assessment of the monolithic character of the waste material.

The total dissolved solids (TDS) are determined as the accumulated release of dissolved solids after 64 days of testing according to CEN/TS 15863 or CEN/TS 15864. The TDS of the individual eluates shall be determined according to EN 15216.

If material falls off the test piece(s) during the performance of CEN/TS 15863 or CEN/TS 15864, it is an indication of poor stability that will probably have been detected already (7.2). CEN/TS 15863 and CEN/TS 15864 include a procedure for determination of the weight loss by material falling off. The relative weight loss, M_R (in %), is calculated from the weight loss, m_d, determined by CEN/TS 15863 or CEN/TS 15864 as $M_R = 100 \times m_d / M_d$, where M_d is the dry mass of the test portion (note that M_d is not determined in the procedures described in CEN/TS 15863 and CEN/TS 15864).

7.5 Expansion

If a monolithic material after being placed in a landfill expands upon exposure to and uptake of water, this may give rise to displacement of material and formation of cracks and thereby loss of integrity. Determination of the expansion of a test specimen after exposure to water for a fixed period of time will provide an indication of the risk that a stabilised/solidified waste material will behave in this way after landfilling.

Expansion is determined by subjecting regularly shaped test specimen (cylinder or cube) with a minimum dimension of 10 cm in accordance to CEN/TS 15863 or CEN/TS 15864 for 36 days. Measure the volume of the test specimen before and after the test and calculate the percentage expansion.

The possible hydration and expansion of some minerals could be too slow to be detected by the above method.

7.6 Organic matter

The release of both inorganic and organic trace substances may be enhanced by the presence of significant amounts of organic matter which may be released as dissolved organic matter, particularly at high pH. If the organic matter is degradable it may further destabilise the matrix in the landfill in the longer term.

The content of organic matter shall be determined as total organic carbon by EN 13137.

The results shall be reported in accordance with the requirements in the standard. For the purpose of assessment of the monolithic character of the waste material, the TOC shall be reported in mg C/kg.

EN 13137 does not distinguish between organic carbon and elementary carbon. This could be considered for some wastes, and TOC could possibly be corrected by determination and subtraction of the content of elementary carbon.

7.7 Freeze/thaw effects

Landfills located in or near arctic regions may be particularly sensitive to this factor which may cause heaves, cracks and crumbling of the stabilised/solidified waste. Frost will generally affect stabilised/solidified waste landfills at moderate latitudes less or not at all if they have a top soil cover that will prevent freezing of the stabilised/solidified waste, provided at least 0,5 m of topsoil is applied. If during landfilling of stabilised/solidified waste some damage to already stabilised/solidified waste occurs, that will generally not be critical when a fresh layer of stabilised/solidified waste is placed over the damaged region.

The *Slab test* given in CEN/TR 15177:2006, Clause 8 shall be used.

The results shall be reported as a relative length change in accordance with the requirements given in CEN/TR 15177:2006. For the purpose of assessment of the monolithic character of the waste material, the degradation resulting from freeze–thaw shall also be reported in terms of visual damage.

8 Expression of results

The results are expressed according to Table 1.

Table 1 — Expression of results

Monolithic characteristics	Results
Sample preparation	Reported according to EN 15002
Compressive strength	Results before and after water exposure in megapascal (N/mm^2)
Permeability	Permeability (in m/s)
Loss of mass (excessive dissolution of salt and/or disintegration)	% loss for each
Expansion	% volume change
Organic matter	mg C/kg
Freezing/thawing effects	% change of length

9 Documentation and test report

9.1 General requirements

The results shall be reported as specified above. In addition the results of each of the tests shall be reported individually in accordance with the respective standards used and appended to the test report. In order to comply with the present standard, the following additional information shall be documented in such a way that it is immediately available upon request. In the following list, at least the items marked with an asterisk (*) shall be included in the test report. All deviations from the minimum requirements of this document shall also be documented in the in the test report.

9.2 General data

— Reference to this Technical Specification*

— Nature and description of the waste*

— Reference of the laboratory sample*

— Date of reception in the laboratory of the laboratory sample*

— Address of the laboratory and name(s) of the responsible person(s)*

— Size (shape and dimensions) and mass of laboratory sample* in m and kg, respectively (refer to sampling report)

— A justification of the selection of individual test procedures - in particular why some of the procedures are not included, if this is the case (regulatory requirements, practical reasons, or other)*

9.3 Sample preparation (for each test procedure)

— Date of preparation of the test portion(s) (e.g. date of cutting, coring, moulding, etc.)*

— Storage condition between reception of laboratory sample and preparation of the test portion(s)

— Duration and storage conditions between preparation of the test portion(s) and different steps of the procedure

— Dry mass (kg), size and shape (dimensions in m), (exposed) surface area and volume (in mm^2 and mm^3) of the test portions(s) as required by the individual procedures*

— Other information as required by the individual procedures shall be reported as part of the appended test reports for these procedure*

9.4 Result of tests

— Address of the laboratory and name(s) of the responsible person(s)*

— Results in accordance with Table 1 in Clause 8 with reference to the individual, appended test reports*

— If criteria are available, a statement whether the waste is monolithic or not monolithic based on the tests performed, shall be included

Bibliography

[1] EN 12457-1, *Characterisation of waste - Leaching - Compliance test for leaching of granular waste materials and sludges - Part 1: One stage batch test at a liquid to solid ratio of 2 l/kg for materials with high solid content and with particle size below 4 mm (without or with size reduction)*

[2] EN 14346, *Characterization of waste - Calculation of dry matter by determination of dry residue or water content*

[3] IUPAC. *A.D. Mc Naught and A. Wilkinson, IUPAC Compendium of chemical terminology*. Blackwell Science, Cambridge, United Kingdom, 1997

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