SLOVENSKI STANDARD
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Karakterizacija odpadkov - Splošno navodilo za karakterizacijo odpadkov iz industrije bogatenja mineralnih surovin

Characterization of waste - Overall guidance document for characterization of waste from the extractive industries

Charakterisierung von Abfällen - Rahmenrichtlinie zur Charakterisierung von Abfällen der mineralgewinnenden Industrie

Caractérisation des déchets - Document guide pour la caractérisation des déchets issus des industries extractives

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Foreword

This document (CEN/TR 16376:2012) has been prepared by Technical Committee CEN/TC 292 “Characterization of waste”, the secretariat of which is held by NEN.

The preparation of this document by CEN is based on a mandate by the European Commission (Mandate M/395), which assigned the development of standards on the characterization of waste from extractive industries. The target audience of this guidance document includes all stakeholders concerned with the management of extractive waste including authorities, regulators, waste producers, consultants and testing laboratories.

The overall guidance document is one out of three guideline documents (TR, technical reports) and one technical specification (TS) on aspects related to the characterization of extractive wastes developed by CEN/TC 292. These four documents are:

— overall guidance document for characterization of waste from extractive industries (CEN/TR 16376);

— guidance on sampling of wastes from extractive industries (CEN/TR 16365);

— kinetic testing for sulfidic waste from extractive industries (CEN/TR 16363); and

— sampling and analysis of cyanides (WAD) discharged into tailings ponds (CEN/TS 16229).

In addition to these four documents CEN/TC 292 developed a European Standard (EN 15875) for static determination of acid and neutralization potential of sulfidic waste (acid-base accounting).

The overall guidance document applies to waste from extractive industries according to the waste definition in Art. 3 para 1 of the Directive 2008/98/EC on Waste. Therefore, as far as residues from the extractive industries are mentioned in this document they are only covered if they fulfil the criteria of the above mentioned waste definition.

This document provides guidance and is not a required procedure. It gives recommendations on what to evaluate during characterization of waste from extractive industries. It provides a tool box with many different methods that may or may not be applicable in a specific case, and it is not a legally binding document.

Introduction

Waste from the extractive industries can only be managed properly if sufficient knowledge about its geochemical and physical properties and behaviour is available. Such knowledge may be obtained through characterization of the waste. Consequently, Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and the associated Commission Decisions on waste facility classification, inert waste definition and waste characterization include several requirements related to characterization of waste.

In one of its decisions the European Commission states that: “The purpose of the characterization of extractive waste is to obtain the relevant information on the waste to be managed in order to be able to assess and monitor its properties, behaviour and characteristics and thereby ensure that it is managed under environmentally safe conditions in the long term. Furthermore, the characterization of extractive waste should facilitate the determination of the options for managing such waste and the related mitigation measures in order to protect human health and the environment.”

A multitude of methods and tools are available for various waste characterization purposes – some are standardized and some are not. Often several methods that differ only slightly from each other are available for the same purpose. Tradition and geography often determine which method is used. In some cases, the use of specific methods is required by legislation. Within EU legislation, European (CEN) Standards and methods are generally preferred if they are available. The implementation of Directive 2006/21/EC and the COM decisions calls for appropriate waste characterization which may be achieved by the use of several characterization methods and standards. Some of these methods and standards have been applied in the extractive industry for many years, while others have been less commonly used in this context. In a few cases, it has been necessary to develop or initiate development of new CEN standards for the purpose.

This overall guidance document has been developed by CEN under mandate M/395 by the European Commission to support stakeholders in the EU Member States involved in the characterization and management of extractive waste in selecting the appropriate waste characterization tools (standards or methods) for a given purpose related to the management of extractive wastes and to the requirements of Directive 2006/21/EC and the associated COM decisions. Furthermore; it is meant to provide information on the possibilities and limitations of the methods and to provide some guidance on where to find further information on the interpretation and application of the waste characterization results. The overall guidance document is intended to cover all the different waste categories produced by the wide range of sectors within the extractive industry and to reflect state-of-the-art with respect to waste characterization methods. It is the purpose of the document to provide the stakeholders with an overall summary of the specific aspects of characterizing waste from the extractive industries, but it will not replace the in-depth expertise required in most cases. Stakeholders include authorities, regulators, operators/waste producers, consultants and test laboratories.

1 Scope

This Technical Report gives guidance and recommendations on the application of methods for the characterization of waste from extractive industries [1], i.e. wastes resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries. The document covers characterization methods for both physical and geochemical properties and also other significant aspects, from planning to interpretation and reporting.

The main purpose of the document is to aid the extractive industry and regulatory agencies in the member states in understanding how to perform waste characterization for planned, active and closed extractive operations.

The document includes a discussion on when and why characterization may be needed and on the contexts within which characterization data may need to be applied. However, it does not cover information on how to apply these characterization results, e.g. for dam design or closure planning. For guidance on how to use characterization results correctly for predictive modelling or design purposes references are made to other sources of information.

The extractive industry covers many different sectors with very different waste categories and characterization may be carried out with many different objectives. For this reason, a guidance document on characterization cannot be prescriptive or provide generally applicable instructions on how waste characterization should be performed in each and every case.

2 Principles and procedures

2.1 Definition and role of waste characterization

Waste characterization is generally understood as the determination of waste properties and behaviour in terms of geochemical characteristics (e.g. composition, reactivity, thermodynamic stability, mineralogy, leaching properties) and physical properties (e.g. particle size distribution, density, permeability, compactibility, physical stability) and the interdependence and changes of these properties under varying conditions.

Whereas the above more general definition of waste characterization is fairly straightforward, the Commission (COM) decision 2009/360/EC on waste characterization applies a broader definition which includes a substantial amount of additional information. The COM decision also addresses background information on the extractive operation in question, geological background of the deposit to be exploited and on the origin and amount of wastes occurring during prospecting, extraction and operation as well as information on the classification, transport and management of the wastes produced[2]. These issues are discussed in Clause 4.

Waste characterization is primarily a management tool. In the extractive industry, waste characterization is often carried out to determine or estimate the present and future behaviour of a given type of waste under specified conditions to facilitate proper management of that waste. One cornerstone of the European legislation on extractive waste is the development of waste management plans, and one key component of a waste management plan is the waste characterization. The waste management plans will cover many aspects related to the waste management. Waste characterization may thus provide important information in many different contexts. For example, it may constitute an important part of an environmental impact or risk assessment, it may be used to assist in the definition of the most appropriate waste management solution in order to achieve physical and geochemical stability of the waste or it may be used to assess the suitability of an extractive waste for various construction purposes.

2.2 The waste characterization process at a glance

The starting point when designing a plan for waste characterization would normally be a definition of the general objective of the characterization exercise and the related questions that should be answered or may need to be answered at some time in the future.

[1] as defined in Article 2 of Directive 2006/21/EC

[2] Sections 1, 2 and 3 of COM decision 2009/360/EC

Waste characterization is related to the short and long-term physical and geochemical stability and environmental performance of the waste facility and is carried out to understand the relevant waste properties in order to predict the behaviour of a waste material in a specified scenario. The properties that are of interest will depend on the situation at hand and the decisions to be made. In many cases, the leaching behaviour of the waste will be a key concern. Short term and medium term leaching potential will be an important input in the decision process with regards to the location and design of dumps or tailings storage facilities and the need for collection and treatment of drainage. The long term leaching potential will be the critical factor in the development of closure plans.

Sulfidic wastes, primarily from some metal and coal mines, require special attention due to the potential weathering of sulfides that may lead to the production of acidic (or neutral) and metal laden drainage, commonly known as acid rock drainage (ARD) or acid/neutral rock drainage (A/NRD).

When the waste management plan includes the construction of waste dumps, or the use of waste for dams or other construction purposes, stability is an issue and physical properties of the waste become a key concern.

To obtain a permit for a new or existing operation it is necessary to characterize the waste. The complexity of this characterization depends on the type of material. For a geologically/mineralogically uncomplicated case, with access to existing information, a field inspection and comparison with other sites with the same type of material may provide sufficient information. For geologically/mineralogically complex sites there may be many samples run for different types of analysis. During operation, sampling and testing may be carried out to check that the initial characterization remains valid and in some cases to check compliance when there are certain criteria that need to be met.

When the general objectives of the waste characterization have been defined the next step will be to define the relevant site specific scenario.

It is only then that decisions can be made on relevant waste properties, which tests to carry out, which methods to use, how many samples are needed and so on.

The sequence of characterization is illustrated in Figure 1.

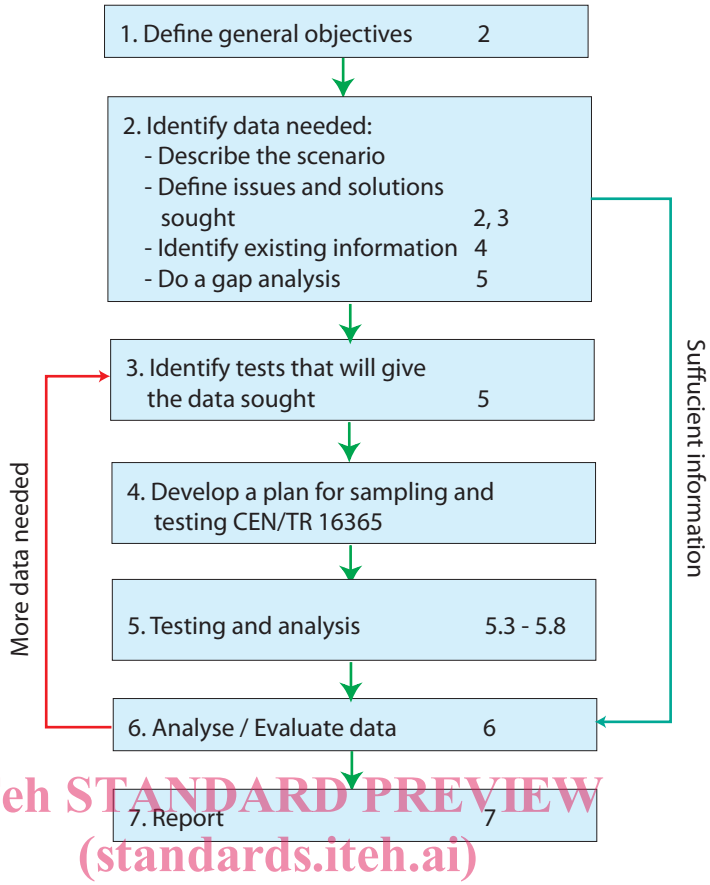

Figure 1 — Flow chart of the characterization process, with references to the clauses within this document

Below follows a simplified, stepwise description of the whole characterization process:

Step 1: Define general objective

As a first step it is important to define and understand the general objective of waste characterization in the specific case. Characterization should always be done with a purpose. Without keeping that purpose clearly in mind it is very easy to end up with an overly ambitious characterization program, or, with results that are too uncertain to allow any conclusions.

Examples of general objectives (most characterization programs will include multiple objectives) with references to current European legislation include:

- development of waste management plans (Dir 2006/21/EC, Art 5.3); including
  - design of waste facilities (Dir 2006/21/EC, Art 11);
  - assessment of leachate generation and design of treatment measures (Dir 2006/21/EC, Art 13);
  - development of closure plans (Dir 2006/21/EC, Art 12);
  - classification of waste facilities (COM decision 2009/337/EC).
- classification of inert waste (Dir 2006/21/EC, Art 3 and COM decision 2009/359/EC);
- calculation of financial guarantee (Dir 2006/21/EC, Art 14 and COM decision 2009/335/EC);

— classification of waste categories according to the European waste list (COM decision 2000/532/EC and subsequent amendments).

Step 2: Identification of data needed

The following four steps will have to be carried out in parallel.

- Describing the scenario

It is useful to document a general description of the scenario at hand (Clause 4) e.g.:

a) the kind of operation, existing or planned (e.g. metal mining, lime stone quarry, salt mining, open-pit or underground, size of mineral deposit);

b) the phase of operation during which the study is conducted (exploration/pre-mining, on-going operation, existing waste dump/disposal site);

c) the character of the surroundings (e.g. urban, industrial, farmland, forest, distance to receiving waters, existence of protected areas, other industrial activities);

d) the kind of waste management foreseen (e.g. disposal in dams, dumps, stockpiling, saturated/unsaturated, separation/mixing).

- Definition of the issues and the solutions sought

Based on the general objective defined in step 1, information about environmental aspects associated with different categories of extractive waste (Clause 3) and given the scenario at hand, specific questions that the operator (or the competent authority) wants to answer by characterizing the waste should be defined.

Examples of questions;

— Will there be a release of drainage from the waste facility? If so, how will the drainage quality develop over time? Will drainage water require collection and treatment to meet water quality standards? If so, what treatment would be appropriate?

— What kind of closure of the waste facility will be needed?

— Will the waste meet short and long-term specifications for construction purposes?

— Is there a potential to optimize the waste management by separation into different categories?

- Identifying existing information

It is not in anyone's interest to carry out characterization work to produce information that is already available. Given the questions that need to be answered, relevant existing information should be identified (Clause 4). This could include:

— mineralogical and geochemical information from exploration/mapping;

— data from previous waste characterization;

— relevant information from comparable operations;

— information on the disposal site, topography, hydrology, geological and geotechnical;

— other local conditions, e.g. climatic data.

- Gap analysis

Does existing data (e.g. available characterization data on the mineralization and on future extractive waste, background information) give sufficient information to answer the relevant questions and to support the management decisions that have to be taken? If that is the case, no further testing is needed at this stage. However, there may still be a need to verify these results over time.

If the conclusion is that more information is needed, these needs should be specified in as much detail as possible to guide the choice of test method and the development of a characterization plan. Part of this specification should be an evaluation of the data quality needed, i.e. what level of uncertainty is acceptable (6.2). This will be important when deciding on a sampling strategy and might influence the choice of test methods.

The gap analysis might also lead to the conclusion that there is a lack of information regarding local conditions or other background information.

Step 3: Identify tests that will give the data sought

There are a large number of test methods for determining different waste properties, but also different methods for determining the same property. Some methods are standardized, some are established industry practice and some are under development. Some methods are applicable to specific types of extractive waste, but not to other types. When considering the use of any test method, its applicability and limitations should be well understood.

Clause 5 gives guidance on what methods are available and may be relevant for the determination of specific properties of extractive waste. Additional information is given in Annexes B to F.

Based on the information needs specified in earlier steps and information on available methods the most appropriate test methods should be identified. In some cases, a visual inspection may be sufficient to confirm that the waste material at hand corresponds to existing information while in other cases a whole package of tests will be needed.

See also 2.3 for some further comments on the choice of test methods.

Step 4: Develop plan for sampling and testing

The development of sampling plans is briefly described in 5.2. EN 14899 describes how the sampling plan for waste characterization should be compiled. Additional information specific for the extractive sector is available in CEN/TR 16365.

It is not possible to give general guidance on the number of samples needed as this will depend, amongst other things, on the amount and quality of background information and on the acceptable level of uncertainty of the results. In general, a more heterogeneous geology will require more samples than a homogeneous rock mass. Typically, exploration data will be used to design a sampling plan that is representative of the whole ore body and potential waste. In the case of sampling of waste from the process, the required frequency of sampling will depend on the variability in the waste stream. A statistical approach is recommended to avoid a situation where the characterization results are inconclusive due to too few, or non-representative, samples (for more information on statistical approaches see CEN/TR 15310-1).

Getting representative samples of future tailings will in many cases require processing of the ore in a pilot plant.

It is important that plans for sampling and testing are coordinated as e.g. the size of samples needed and potential pre-treatment or conservation requirements will be given by the test method(s) chosen. A general recommendation is to always collect and store extra material during sampling to allow for additional tests without renewed sampling (when testing is done on stored samples potential ageing effects will have to be considered).

Step 5: Carry out sampling and testing

Guidance regarding field sampling is given in CEN/TR 16365. It should be noted that sampling of extractive waste may present some very specific health and safety risks that shall be taken into account and managed (2.4).

When a high accuracy of the test results is needed it is recommended to use laboratories accredited for the test methods in question (not applicable for methods or within jurisdictions that are lacking accreditation schemes). General quality assurance and quality control (QA/QC) procedures should always be applied.

Step 6: Analyse/evaluate

When test results are reported they will have to be analysed and evaluated by a suitably qualified person with experience and knowledge of the behaviour of mineral wastes (Clause 6). It should be assessed whether these results allow the questions defined in the beginning of the process to be answered with an acceptable level of certainty. If not, additional sampling and/or testing will be needed (i.e. back to step 3 or 4).

There may e.g. be a need to take more samples because the waste proves to be more heterogeneous than expected, or the testing program may need to be complemented with more sophisticated methods to allow conclusions to be drawn.

In some cases the evaluation will be quite simple and straight forward: e.g. a comparison of total content with given criteria.

In other cases, the evaluation will involve interpretation of results, sometimes in combination with sophisticated modelling. E.g. when making assessments of drainage quality based on leaching tests. The scope of this document is limited to the characterization as such. Further guidance on how to carry out modelling, other than the overview of available modelling tools in Annex H, will have to be found elsewhere.

Step 7: Report

The whole characterization procedure should be documented and reported (Clause 7). It is important that the report covers not only final results and conclusions, but also the previous steps in the procedure, i.e. what decisions were made and why. What was the objective of the characterization, what background information was used, what assumptions were made etc.

Additional reports may be considered for specific audiences.

2.3 Choice of test methods

This guidance document roughly groups test methods (and properties) into:

— mineralogical analysis (5.3);

— geotechnical methods (5.4);

— geochemical analysis (5.5);

— leaching tests (5.7).

In the case of waste containing sulfide minerals, methods to evaluate acid generation and buffering potential have been developed (5.6). They can be divided into static (Acid-base accounting) and kinetic tests.

Figure 2 and the following text give an overview of categories of test methods and how they relate to potential waste management issues.

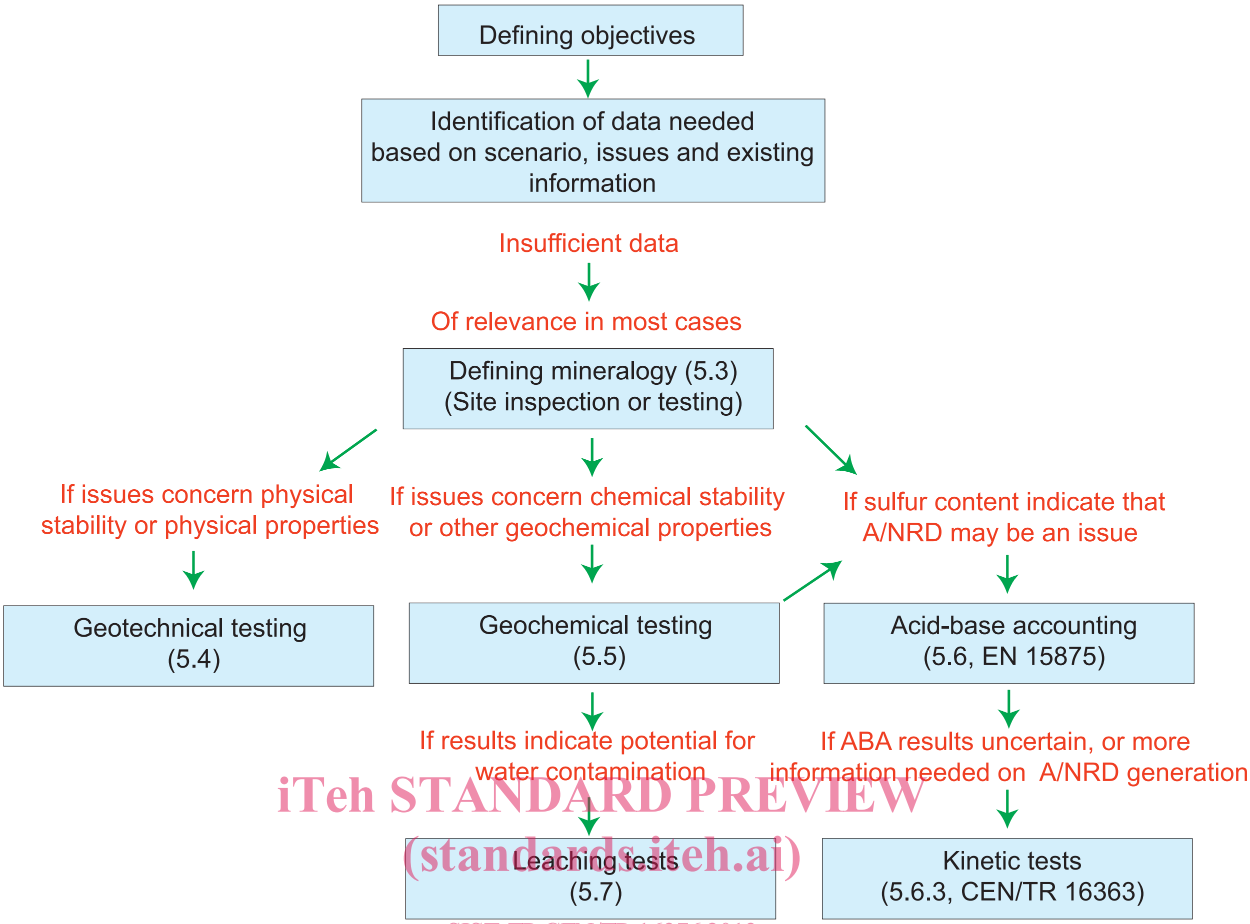

Figure 2 — Examples of sequences of testing in extractive waste characterization

For an assessment of the properties of extractive waste, a good knowledge of the mineralogy of the waste material is generally necessary. This information is essential for the evaluation of results from chemical analysis and leaching tests as well as for the assessment of A/NRD potential. Mineralogical information may be available from geological mapping and/or exploration efforts. An analysis of the mineralogy may take different forms. Depending on the quality of existing information and the complexity of the geology a visual inspection may be sufficient, while in other cases, advanced laboratory equipment such as electron microscopes or X-ray may be needed.

The physical properties of the waste relate, in particular, to two main aspects:

— Physical stability; e.g. slope stability of waste dumps or tailings used in dam construction, including changes of the stability due to physical or chemical weathering;

— Hydrology of the waste facility; e.g. infiltration rates, residence times, water saturation. Hydrology is a key factor in assessing the performance of any given waste facility design.

Chemical analysis to determine total concentrations of relevant substances will be part of most characterization programs. The substances of relevance are different for different types of waste from the extractive industry. Many test methods detect a whole range of substances, which may be useful for screening. However, characterization should focus on those substances that can potentially exceed critical levels in future discharges or, if the characterization is aimed at classification of the waste, those substances where relevant thresholds might be exceeded.

For an assessment of environmental impacts the total content is not representative of what may be released from the waste. There are different leaching tests available for this determination. Some tests will give total leachable amounts; others will be more relevant for an assessment of drainage quality.