SLOVENSKI STANDARD
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Karakterizacija blata - Dobra praksa za odlaganje blata in ostankov po obdelavi blata

Characterization of sludges - Good practice for landfilling of sludges and sludge treatment residues

Charakterisierung von Schlämmen - Gute fachliche Praxis bei der Deponierung von Schlamm und Rückständen aus der Schlammbehandlung

Caractérisation des boues - Bonne pratique pour la mise en décharge des boues et des résidus de traitement des boues

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Characterization of sludges - Good practice for landfilling of sludges and sludge treatment residues

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This Technical Report was approved by CEN on 24 April 2005. It has been drawn up by the Technical Committee CEN/TC 308.

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Foreword

This document (CEN/TR 15126:2005) has been prepared by Technical Committee CEN/TC 308 “Characterization of sludges”, the secretariat of which is held by AFNOR.

This document is voluntarily presented in the form of a CEN Technical Report because most of its content is not completely in line with practice and regulations in each Member State. This document gives recommendations for good practice concerning the landfilling of sludges and sludge treatment residues, but existing national regulations remain in force.

Introduction

All the recommendations in this document constitute a framework within which the landfilling process can be proposed as a substitute for field spreading, or in addition to specific or combined incinerations, or any other process.

This document should be read in the context of the requirements of Directive 1999/31/EC on the landfill of waste which applies to the landfill of sludge and any other relevant regulations, standards and codes of practice which may prevail locally within Member States.

1 Scope

This CEN Technical Report gives one of a series of sludge management options and describes good practice for the disposal of sludges and sludge treatment residues to landfill where national regulations permit.

This document is applicable to the sludges described in the scope of CEN/TC 308, i.e. specifically derived from:

— storm water handling;

— night soil;

— urban wastewater collecting systems;

— urban wastewater treatment plants;

— treating industrial wastewater similar to urban wastewater (as defined in Directive 91/271/EEC);

— water supply treatment plants;

— water distribution systems;

but excluding hazardous sludges from industry.

2 Normative references

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

EN 1085:1997, *Waste water treatment – Vocabulary*

EN 12832:1999, *Characterisation of sludges – Utilization and disposal of sludges – Vocabulary*

EN 13965-1:2004, *Characterization of waste – Terminology – Part 1: Materials related terms and definitions*

EN 13965-2:2004, *Characterization of waste – Terminology – Part 2: Management related terms and definitions*

CR 13714, *Characterisation of sludges – Sludge management in relation to use or disposal*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in EN 12832:1999, EN 1085:1997, EN 13965-1:2004, EN 13965-2:2004 and also in the following Directives apply:

Directive 91/271/EC concerning urban wastewater treatment

Directive 75/442/EC the waste framework directive as amended by Directive 91/156/EC

Directive 1999/31/EC on the landfill of waste.

Directive 2001/77/EC on renewable energy.

For the understanding of this document, these abbreviated terms apply:

BIO: Biomass

BOD: Biological Oxygen Demand

COD: Chemical Oxygen Demand

CSO: Chemically Stabilized Organic

DPM: Decomposable Plant Material

MSW: Municipal Solid Waste

PSO: Physically Stabilized Organic

RPM: Resistant Plant Material

TOC: Total Organic Carbon

VFA: Volatile Fatty Acids

WWTP:

4 Outline of landfill processes

4.1 General

The landfill processes which are of importance for understanding the potential for controlling waste stabilization are the physical, chemical and microbial activities which lead to the modification of waste, from often complex substances with significant pollution potential to simpler compounds which can be environmentally benign. In the case of a landfill containing degradable waste, the principal processes of interest are those which lead to the breakdown of complex organic compounds found in the putrescible fraction of non-inert waste, and the influence of the by-products of degradation on the mobility and availability of other compounds and elements. At a simple conceptual level, a landfill can be viewed as a reactor vessel in which solid, water and gaseous inputs are subject to a variety of processes which produce solid, liquid and gaseous waste products. The reactor model for landfill processes is shown schematically in Figure 1, with the inputs, processes and outputs summarized briefly below.

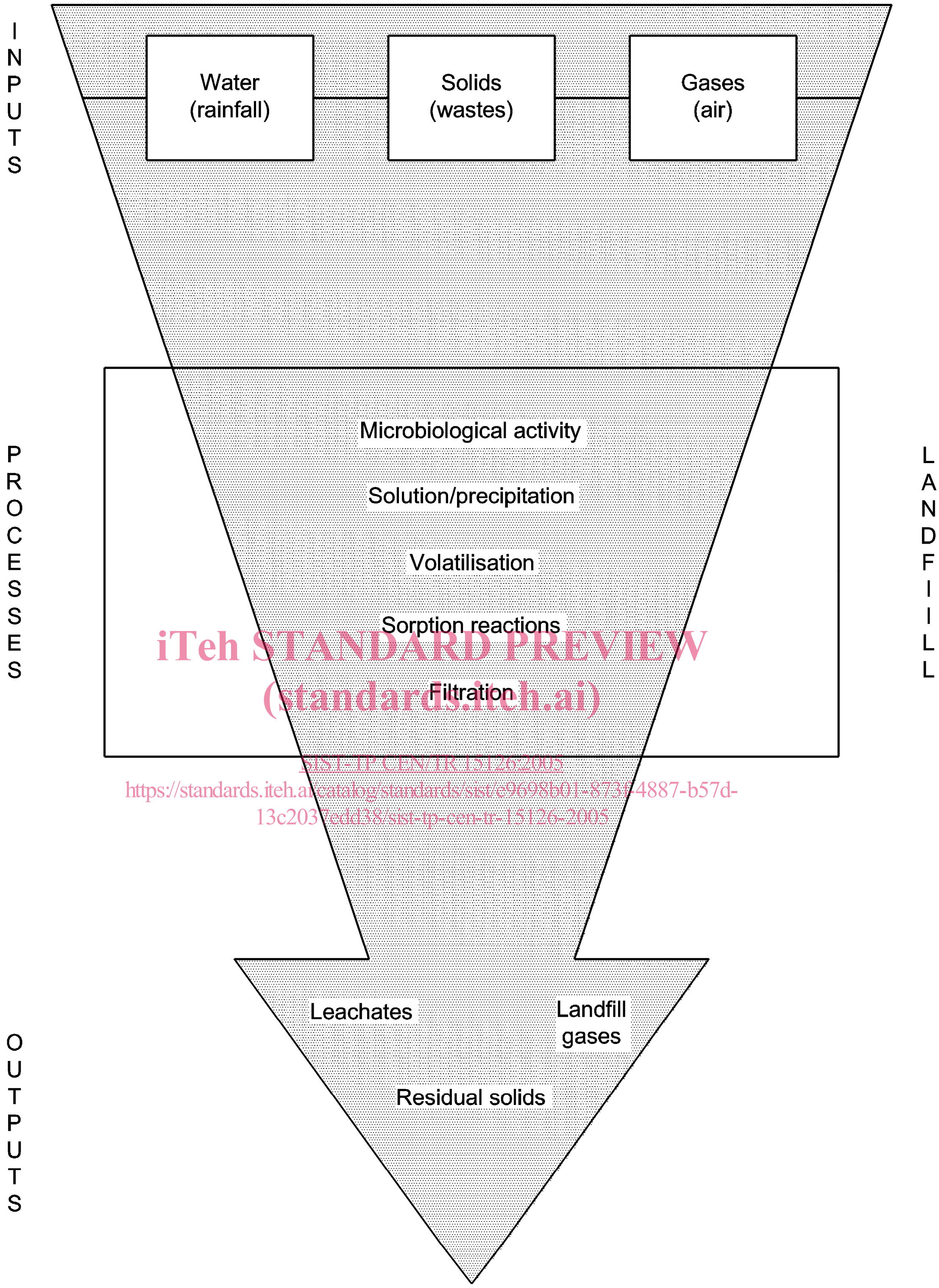

Figure 1 - Schematic representation of landfill processes

4.2 Inputs

4.2.1 Water

The principal water input at modern, managed, cellular landfill sites is rainfall which can gain direct access to waste during the filling phase for each cell and indirectly by percolation through capping and restoration layers after each cell is finished. Solid waste contains absorbed water and mixed household waste typically carries about 25 % water on a wet mass basis. Sludges contain about 10 % to 95 % water according to the extent of dewatering and drying treatment they have received (for information concerning national regulations about the water content, see Annex A).

4.2.2 Solids

Sludge, household waste and to a lesser extent commercial and industrial waste, contain putrescible materials which degrade within the landfill environment, giving rise to potentially polluting liquid and gaseous products. The process of degradation can create conditions in which other, non-organic compounds can pass into solution or enter a gaseous phase. About 20 % of household waste is rapidly biodegradable (putrescible) and a further 30 % more slowly degradable (cellulosic materials such as paper). In the case of sludge, about 30 % is rapidly biodegradable, 40 % progressively more slowly degradable and the remaining 30 % is non-degradable, inorganic ash. Articles 5.1 and 5.2 of the Landfill Directive (1999/31/EC) require that the biodegradable municipal waste deposited in landfill should be reduced progressively so that by 2016 the amount (by mass) of biodegradable municipal waste should not be more than 35 % of the mass produced in 1995. These targets will be achieved in part by composting and separation and recycling of waste. Sludge for landfill disposal should be stabilized (for instance, by aerobic or anaerobic digestion or by composting or lime stabilization or by acid treatment) to remove the rapidly biodegradable fraction and dewatered because liquid waste is unacceptable according to Article 5.3 of the Landfill Directive. However, under Article 2 (q), liquid waste is defined as any waste in liquid form including wastewaters, but excluding sludge.

4.2.3 Gases

The pore spaces of inert or slowly reactive solid waste arriving at a landfill normally contain a gaseous mixture close to that of the atmosphere, that is 79 % nitrogen and slightly less than 21 % oxygen, with the balance composed principally of carbon dioxide and trace amounts of other gases. The pore gases of putrescible waste can reflect rapid decomposition, in terms of reduced oxygen and increased carbon dioxide levels before deposition in the fill. The pore gases in and around sewage sludge will contain some methane and hydrogen sulfide (and other odorous compounds) as well as carbon dioxide. Sludge addition to an MSW landfill can accelerate gas production and stabilization of the landfill by a bioreactor effect (see [1]).

4.3 Processes

4.3.1 Microbiological activity

The breakdown of natural organic substances and certain man-made compounds is achieved largely through the activity of various microorganisms which consume the materials as food sources and, in so doing, release soluble and gaseous waste products and energy in the form of heat. The organisms can be aerobic, i.e. they require the presence of free oxygen (O_2 gas) for their metabolic processes or they can be anaerobic, when they gain their energy from the dissociation of compounds in the absence of free oxygen. Some organisms are strict aerobes or anaerobes and can operate only in one mode, but some microorganisms are able to switch from one form of respiration to the other. The breakdown processes can release directly into solution elements and compounds which form part of the original material, whilst waste products of this metabolism can encourage the dissolution of other materials, for example, by producing acidic conditions.

The incorporation of anaerobically digested sludge into a landfill represents an inoculum of bacteria which may accelerate anaerobic biodegradation within the landfill. This will be advantageous if the landfill is being run as a flushing bioreactor and by increasing the rate of stabilization within the landfill, the sludge can shorten the time to safe closure and completion of the landfill. Some authorities consider that if this concept becomes reality, the use of sludge will play an integral part in its design and operation (see [2])

4.3.2 Solution/precipitation

The direction of chemical reactions between the waste components and the liquids moving through the waste (leachate) is controlled by factors such as the relationship between the solubility of elements and compounds and the pH value and of their responses to Eh changes, that is the presence or absence of free oxygen (oxygenated systems have a positive Eh values, reducing systems a negative Eh). As an example, the solubility of many metals is increased as acidity rises (pH values fall to below 7,0), whilst iron is relatively soluble when reducing conditions are present (negative Eh value), but far less soluble in oxygenated environments (positive Eh). The physico-chemical conditions within landfilled waste change during the breakdown and stabilization process (described below) and elements and compounds which are dissolved at one stage in the lifecycle of a landfill can become immobilized by precipitation at another stage, and *vice versa*.

4.3.3 Volatilization

The conversion of liquids (or occasionally solids) to the gaseous state is encouraged by increased temperatures. Microbiological activity can raise the temperature within a waste mass from the average ground temperature of about 10 °C to values in the range 30 °C to 40 °C or more if the waste layer is very thick. Consequently, the gaseous mixture within the waste mass can contain not only the gases produced by the breakdown or organic matter, but water vapour and volatilized hydrocarbons, solvents and similar compounds derived directly from waste materials.

4.3.4 Sorption reactions

Two groups of processes can be involved:

— *absorption*, in which liquid is stored in the pores of the solids, but from which it cannot drain under gravity. The liquid and its dissolved content can be released from the pores if the material is compacted (squeezed) and the liquid can be removed from the pores by evaporation, leaving behind the originally dissolved components;

— *adsorption*, in which elements and compounds are immobilized by becoming attached to the surface of the solids. Many organic compounds in solution or emulsion will attach themselves preferentially to stable organic solids (humic substances, for example), whilst many clay minerals (and other minerals with layer-lattice molecular structure) exhibit the property of base exchange in which cations in solution (for example, metals, ammonium ions) exchange with other cations which form part of the mineral structure. The effect can be reversible so that a cation which has been removed from solution could be released back into solution if the physico-chemical conditions change.

4.3.5 Filtration

A landfilled mass of waste is a coarse, heterogeneous, granular deposit in which liquids and gases move through pore spaces. The liquids can carry particulates in the form of fragments of material detached by decay processes, precipitates and microbial organisms. Removal of particulates from transport by filtration in pore throats can take place, more particularly as the waste decays and collapse of the larger voids leads to compaction and a reduction in the average pore size. The movement of liquids in landfills is predominantly vertically downwards, in response to the gravitational field, and the blinding of pores in the lower parts of landfills contributes to the progressive reduction in hydraulic conductivity of waste with age and depth of burial.

4.4 Outputs

The principal outputs for a landfill containing biodegradable waste are summarized in Figures 2 and 3. An initial aerobic stage (Phase I) is short-lived. Aerobic bacteria begin the breakdown of organic materials and in so doing consume oxygen and release carbon dioxide and water. Aerobic degradation is metabolically vigorous and a rapid rise in temperature of the waste mass is possible. Once the free oxygen has been consumed, anoxic conditions set in (Phases II and III) and organically strong leachates are produced. The methanogenic bacteria which become active as the wastes move from Phase II into Phase IV are sensitive to pH and become inhibited at values below about pH 6,4. Waste which has partly degraded retains a significant