SLOVENSKI STANDARD
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Karakterizacija blata - Dobra praksa za postopek/ke odstranjevanja vode

Characterization of sludges - Good practice of sludge dewatering

Charakterisierung von Schlämmen - Gute fachliche Praxis der Schlammentwässerung

Caractérisation des boues - Bonnes pratiques pour la déshydratation des boues

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TECHNICAL REPORT

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Characterization of sludges - Good practice of sludge dewatering

Caractérisation des boues - Bonnes pratiques pour la déshydratation des boues

Charakterisierung von Schlämmen - Gute fachliche Praxis der Schlammentwässerung

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (FprCEN/TR 16456:2012) has been prepared by Technical Committee CEN/TC 308 "Characterization of sludges", the secretariat of which is held by AFNOR.

This document is currently submitted to the Technical Committee Approval.

Introduction

Sludge processing train is a major problem in water and wastewater treatment, as it can account for up to 50 % of total operating costs. The effectiveness and cost of sludge treatment and disposal operations are strongly affected by its volume and, consequently, by its water content or solids concentration. Thickening and dewatering are therefore important steps in the total sludge processing train and have serious impact on subsequent operations.

For illustration, Figure 1 shows the existing solutions for sludge water content reduction, and Figure 2 shows the level of dry matter content required for intended utilization and disposal routes.

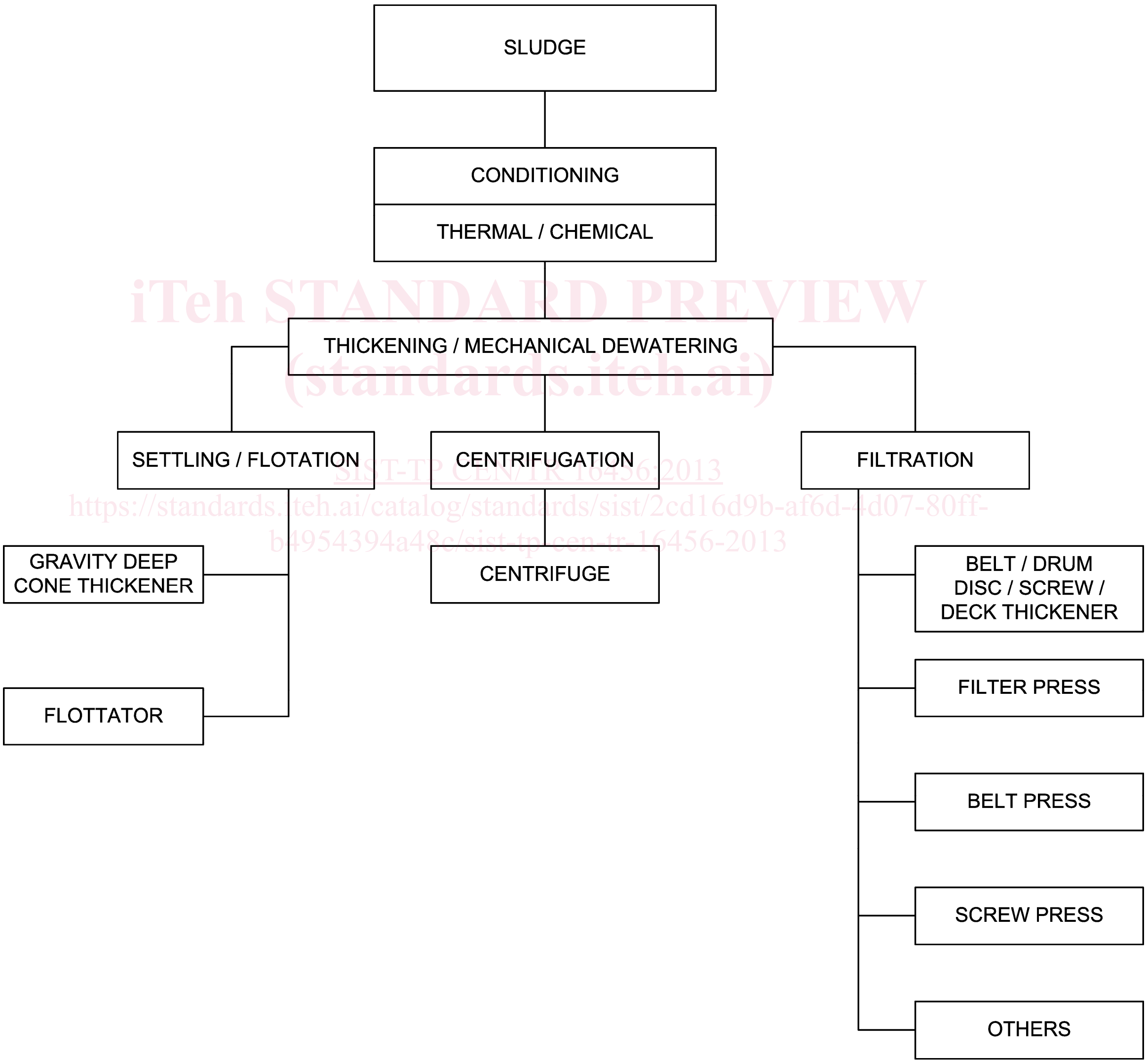


Figure 1 — Principal thickening / dewatering processes

This guide deals with the dewatering and thickening techniques quoted in Figure 1.

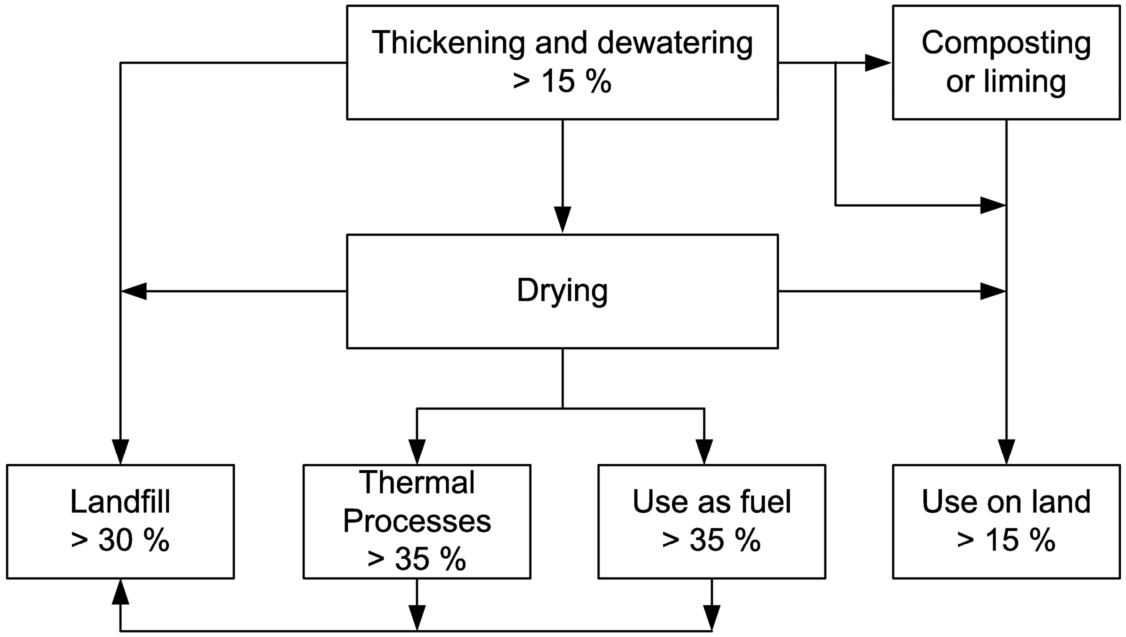


Figure 2 — Percentage Dry Solids (DS) usually required after thickening and dewatering for intended routes

Sludges management options are developed in a series of CEN Technical Reports to which belong the present report, see Figure 3 below.

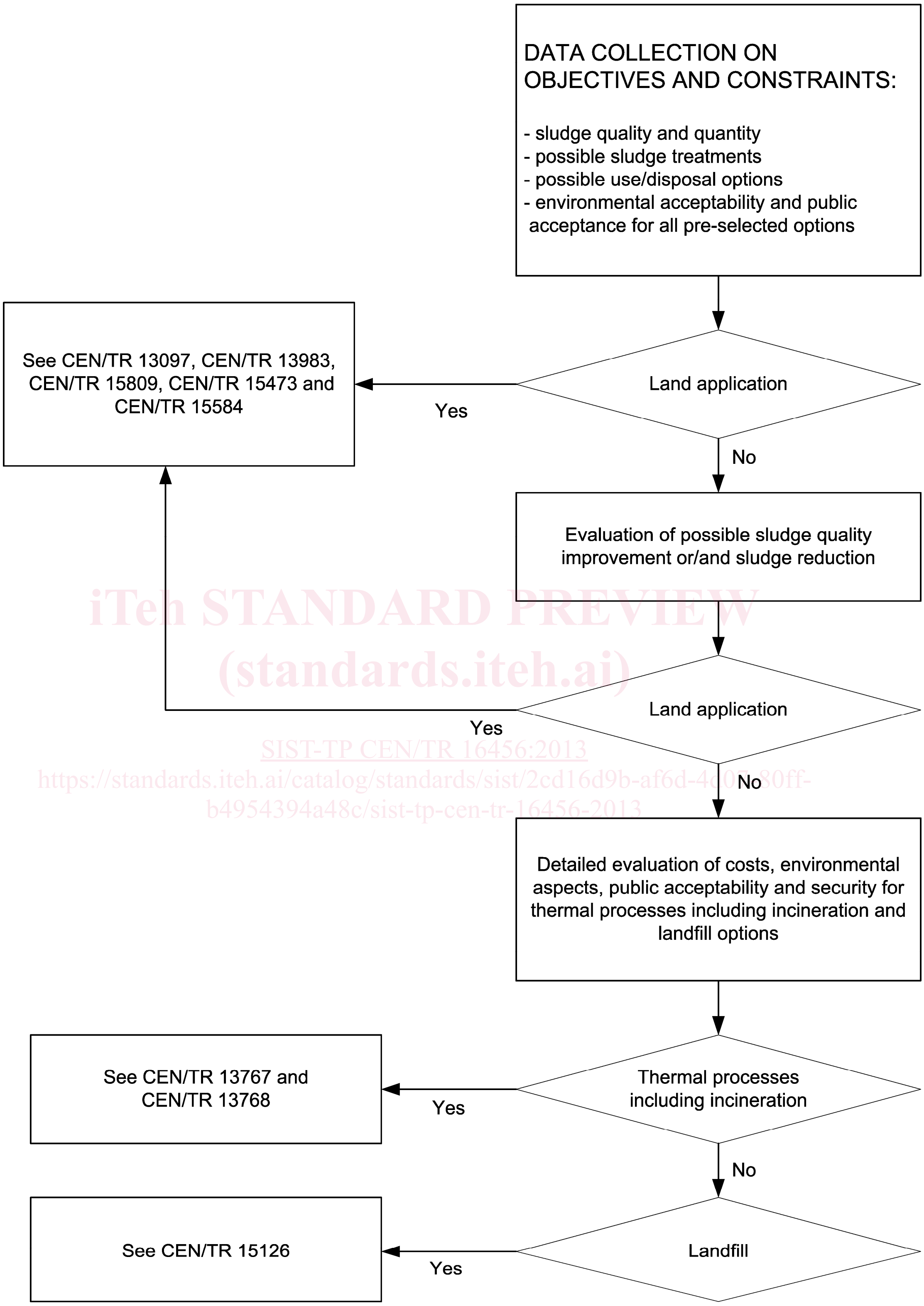


Figure 3 — A basic scheme for deciding on sewage sludge use/disposal options and the relevant CEN/TC 308 guidance documents

1 Scope

This CEN Technical Report describes good practice for sludge dewatering and belongs to a series on sludge management options.

It gives guidance on technical and operational aspects of:

— Conditioning, thickening and dewatering processes.

Drying, which is another water content reduction process, is not dealt with in this document but in CEN/TR 15473, *Characterisation of sludges — Good practice for sludges drying*.

This report is applicable for sludges from:

— urban wastewater treatment plants;

— treatment plants for industrial wastewater similar to urban wastewater;

— water supply treatment plants.

This document may be applicable to sludges of other origin.

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 12832:1999, *Characterization of sludges — Utilization and disposal of sludges — Vocabulary*

prEN 16323:2011, *Glossary of wastewater engineering terms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12832:1999, in prEN 16323:2011 and the following, taken either from the normative references or from technical dictionary [1], apply.

3.1
cake
solid fraction of sludge as resulting from a solid-liquid separation process

3.2
centrate
sludge liquor separated by centrifugation

3.3
centrifugation
partial separation of solid from liquid under centrifugal forces

3.4
charge density
percentage of positive or negative charge

3.5
compressibility
ability of a sludge to be compressed under pressure

3.6
compression point
sludge solids concentration at which compression begins in a sedimentation process

3.7
desaturation
removal of water due to displacement of water by air

3.8
draining / drainage of sludge
separation of water from sludge liquor by gravity filtration

3.9
dryness
ratio of dry solids to sludge mass

3.10
electroosmosis
movement of liquid relative to a stationary charged surface as induced by an electrical field

3.11
expression
removal of sludge water due to deformation of solids under pressure

3.12
filter
device for the removal of sludge water whereby solids are retained on a water-permeable filter medium

3.13
filter medium
material where through a fluid flows and which retains matter contained in the fluid

3.14
filterability
characteristic describing the ability of sludge to be filtered

3.15
filtrate
sludge liquor separated by filtration

3.16
filtration
process of retention of the suspended matter by passing through a medium

3.17
floc
aggregate of particles that results from a flocculation process

3.18
flotation
raising of suspended matter in liquid to the surface by the entrainment of a gas

3.19
"g"
gravitational acceleration (9,81 m/s^2)

3.20
isolelectric point
condition in which a substance has a neutral charge

3.21
mesh
interlacing of crossed wires that determines the openings which can be square, triangular or rectangular

3.22
molecular weight
chain length of a polymer

3.23
particle size distribution
relative amount of particles classified per size ranges

3.24
polymer
class of natural and synthetic materials which are formed by association of structural units (monomers) by covalent bonds

3.25
porosity
ratio of the void volume to the total volume of material

3.26
pre-treatment
improvement of sludge characteristics by physical or chemical means

3.27
rheology
study of flow and deformation properties under the influence of an applied stress

3.28
saturation
ratio of the volumes of water and pores in a solid matrix

3.29
sieve (sludge treatment)
device for removing solids from fluids whereby the fluid flows through slots, perforations or a mesh

3.30
settling
ability for sludge solids to separate from water by sedimentation under gravity

3.31
sludge liquor
liquor separated from sludge. Sludge liquor can be called supernatant, filtrate and centrate

3.32
specific cake resistance
property representing the resistance to filtration of a layer of particles, having a unit mass of dry solids deposited on a unit filtering area

3.33
supernatant
sludge liquor separated by gravity thickening

3.34
water distribution
different physical states of water associated with sludge solid particles

3.35
zeta potential
electrical potential present at the plane of slip when a particle moves relative to its suspending liquid (or vice versa)

4 Description and features of thickening / dewatering systems

4.1 Thickening devices

4.1.1 General

Thickening devices enable the removal of free water from sludge. They are based on:

— natural (static) forces;

— artificial forces.

Thickening presents the following advantages:

— reduction of sludge volume with low energy consumption;

— reduction of storage capacities and volumes for subsequent treatment;

— reduction of transport costs;

— improvement of performance of dewatering machines;

— decrease in quantity of chemicals for dewatering in some cases.

This section discusses the most commonly used devices for thickening.

4.1.2 Devices based on natural forces (gravity)

4.1.2.1 General

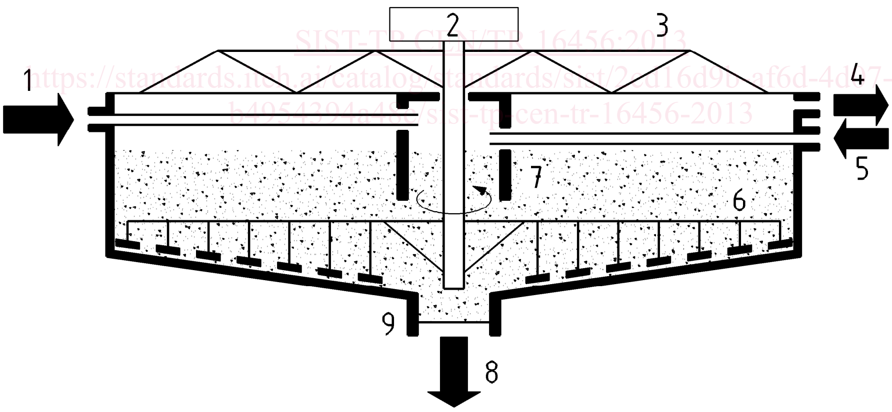
The principle of gravity thickening relies on sludge settling under the effect of gravitational forces. It enables the raising of the concentration of a suspension through sedimentation to produce a thickened sludge with a relatively clear liquid as overflow. Thickeners can be designed to operate in either the batch or continuous mode.

Sludge thickening can be achieved in clarifiers or separate thickeners which provide for a greater sludge storage capacity.

4.1.2.2 Gravity thickener

The traditional gravity thickener (Figure 4) comprises a relatively shallow, open top cylindrical/rectangular tank with either a flat bottom or a bottom shaped in the form of an inverted cone. The feed mixture is gently and continuously introduced to the feedwell. The supernatant is removed via an annular weir at the top of the unit and sludge solids are removed from a well at the bottom. Slowly rotating rakes mounted on a central shaft aid the thickening process by directing thickened solids towards the well for subsequent discharge and by creating channels to release further liquid from the sludge.

Tanks with a diameter smaller than 25 m are usually formed from steel and have bottoms with an angle usually less than 10° equipped with rake arms. Larger tanks between 25 and 200 m diameter are normally made from a combination of concrete and steel and employ rakes designed to match the angle of the conical bottom.



Key

1	feed	6	rake
2	drive head	7	feedwell
3	walkway	8	thickened suspension (underflow)
4	supernantant (overflow)	9	well
5	flocculant		

Figure 4 — Gravity thickener [1]

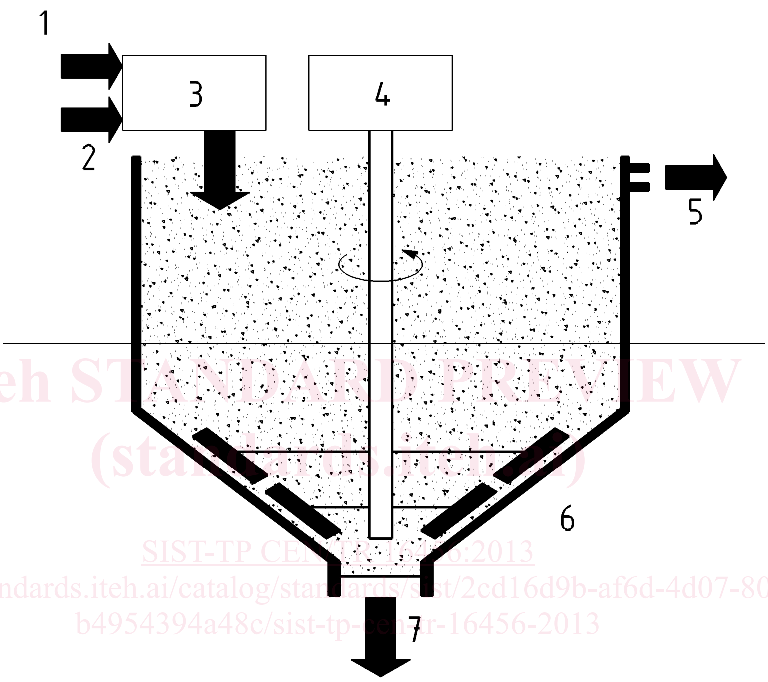
When space is limited, the lamellar separator is used. It is a rectangular tank containing a series of closely spaced rectangular plates inclined at an angle of higher than 50° to the horizontal.

Commercial designs provide three flow patterns, cross-flow, parallel flow and the most common counter–flow where the feed and supernatant flows can be most simply arranged.

The choice of a lamella separator is mainly related to the concentration of the input sludge.

4.1.2.3 Deep cone thickener

A deep cone thickener (Figure 5) has the same operation principle as a conventional circular gravity thickener but the slopes of the bottom are far steeper and have an angle in the region of 37°. Units are available with diameters of up 15 m. A rake rotating at speeds between 0,25 and 2 rpm is usually provided in order to aid the thickening process and increase the underflow concentrations.



Key

1 fast acting flocculant
2 feed
3 mixing device
4 motor drive
5 supernatant (overflow)
6 rake and scraping arms
7 thickened suspension (underlow)

Figure 5 — Deep cone thickener [1]

4.1.3 Devices based on flotation

Flotation thickeners are process devices wherein solid particles are separated from the liquid phase by becoming attached to air bubbles. The particles float to the water surface and are removed with skimmers. The most common device is dissolved air flotation (Figure 6) which uses pressurised air (300 to 600 kPa) and dissolves it in pressurized water. The pressure is then suddenly released to form small bubbles with a diameter of 40 µm to 80 µm. Bubbles are mixed with sludge (direct flotation) or with sludge diluted by underflow water (indirect flotation).