SLOVENSKI STANDARD
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Karakterizacija blata - Lastnosti filtriranja - 4. del: Določevanje odcejalnih sposobnosti izkosmičenega blata

Characterization of sludges - Filtration properties - Part 4: Determination of the drainability of flocculated sludges

Charakterisierung von Schlämmen - Filtrationseigenschaften - Teil 4: Bestimmung der Entwässerung von geflockten Schlämmen

Caractérisation des boues - Propriétés de filtration - Partie 4 : Détermination de l'aptitude à l'égouttage des boues floculées

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English Version

Characterization of sludges - Filtration properties - Part 4: Determination of the drainability of flocculated sludge

Caractérisation des boues - Propriétés de filtration - Partie 4 : Détermination de l'aptitude à l'égouttage des boues floculées

Charakterisierung von Schlämmen - Filtrationseigenschaften - Teil 4: Bestimmung der Entwässerbarkeit geflockter Schlämme

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 14701-4:2018) has been prepared by Technical Committee CEN/TC 308 "Characterization and management of sludge", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2019 and conflicting national standards shall be withdrawn at the latest by June 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14701-4:2010.

EN 14701, *Characterization of sludges — Filtration properties* consists of the following parts:

— *Part 1: Capillary suction time (CST);*

— *Part 2: Determination of the specific resistance to filtration;*

— *Part 3: Determination of the compressibility;*

— *Part 4: Determination of the drainability of flocculated sludges.*

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The determination of drainability of flocculated sludge is an important parameter for evaluating their ability to be thickened by means of a draining process. It gives indications for the choice of flocculant or their dosage in view of the thickening of the sludge through a filtering medium. These easy and quick tests are the best means to narrow the number of products to be tested in full scale experiments and to adapt the pre-treatment to the sludge variability.

The results of measurements obtained are the mass of filtrate collected in a standard time or the time required to recover a given volume of filtrate (commonly 50 % of the water content of the sludge), the maximum volume of filtrate and the corresponding wet and dry mass of the sludge, the undissolved solids remaining in the filtrate and the best flocculant and its optimum dose in the case of comparative tests. In order to ease the comparison of products and their dosing, an adimensional number gathering the different information obtained during a drainage test: kinetics data of filtrate release, filtrate and thickened sludge quality can be used.

1 Scope

This document specifies a method for the determination of drainability of flocculated sludge. It is applicable to sludge and sludge suspensions from:

— storm water handling;

— 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.

This method is also applicable to sludge suspensions from other origins.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 872, *Water quality — Determination of suspended solids — Method by filtration through glass fibre filters*

EN 14742, *Characterization of sludges — Laboratory chemical conditioning procedure*

EN 15934, *Sludge, treated biowaste, soil and waste — Calculation of dry matter fraction after determination of dry residue or water content*

EN 16323, *Glossary of wastewater engineering terms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16323 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
drainability
ability of treated sludge to separate from sludge liquor by gravity filtration

3.2
flocculation
coagulation by means of inorganic flocculants or organic ones (polyelectrolytes)

4 Sludge conditioning

For flocculation, the sludge will be mixed with flocculant in repeatable and quantified conditions according to EN 14742 for a laboratory preparation or sampled already flocculated.

5 Principle

A given volume of flocculated sludge is poured in a filter cell, the mass of filtrate collected is recorded versus time and the corresponding wet and dry mass of the sludge retained on the filtering medium and the undissolved solids remaining in the filtrate are measured.

6 Apparatus

Ordinary laboratory apparatus and the following (see Annex A):

6.1 Transparent tube (e.g. glass, polyethylene, etc.) of 150 mm diameter and of about 200 mm height. It is supported by a system composed of a filtering medium tightened in a device equipped with an appropriate sealing joint.

6.2 Filtering medium whose characteristics shall be the same of that used in the full scale drainage device and in comparative tests.

6.3 Filtrate draining device fixed under the filtering medium.

6.4 Beaker for the filtrate collection.

6.5 Weighing balance with an accuracy of at least 0,1 g connected to a computer to continuously record the cumulative mass of filtrate collected over time. The software will be able to record data every 0,5 s.

6.6 Apparatus for the determination of dry solids content of the sludge retained on the filtering medium (see EN 15934).

6.7 Apparatus for the determination of suspended solids in the filtrate (see EN 872).

To allow a correct interpretation of data, the comparison of flocculation conditions should be made with the same test equipment.

7 Procedure

a) Prepare the balance and the software to record the mass of filtrate as soon as the first drops of filtrate are collected.

b) Measure the water content of the flocculated sludge.

c) Prepare (1± 0,2) l of flocculated sludge and record the exact mass.

d) Gently pour (without shaking) the flocculated sludge in the centre of the cell for the sludge to recover the whole surface of the filtering medium.

e) Record the cumulative mass of filtrate collected over time every 0,5 s at least during the first 30 s.

f) Stop the test when the mass of filtrate to initial mass of sludge ratio is constant to within 0,1 g or after 10 min.

g) Measure the concentration of suspended solids in the filtrate, according to EN 872, and the wet and dry mass of the sludge retained on the filter medium, according to EN 15934.

8 Expression of results

Plot adimensional mass ratio versus time:

$$\frac{m}{m_0} = \text{f (t)} \tag{1}$$

where

m is the mass of filtrate, in g;

m_0 is the initial mass of sludge, in g;

t is the time of experiment, in s.

Record the following data obtained for each test:

a) adimensional mass ratio of filtrate recovered at t = 30 s, t = 90 s and at the end of the test;

b) reference time necessary to collect a volume of filtrate corresponding to 50 % of the water content of the sludge;

c) dryness of the cake retained on the filtering medium;

d) dry mass of suspended solids per unit volume of filtrate.

NOTE The optimal operating conditions are those for which the drainage is the fastest to remove the maximal drainable quantity of water, the mass of wet and dry solids retained on the filter medium is the highest, and the mass of suspended solids in the filtrate is the lowest.

9 Calculation of the drainability index

The specific time required to recover 90 % of the total mass of filtrate determined as illustrated in Figure 1, the final sludge dryness after thickening and the solids content in the filtrate allow the calculation of the drainability index (E_g) which is the ratio of 3 parameters:

— Solids concentration factor assessed by the ratio of the thickened sludge dryness (Si_f, %) at the end of the test and the initial solids content of the sludge (Si_0, %).

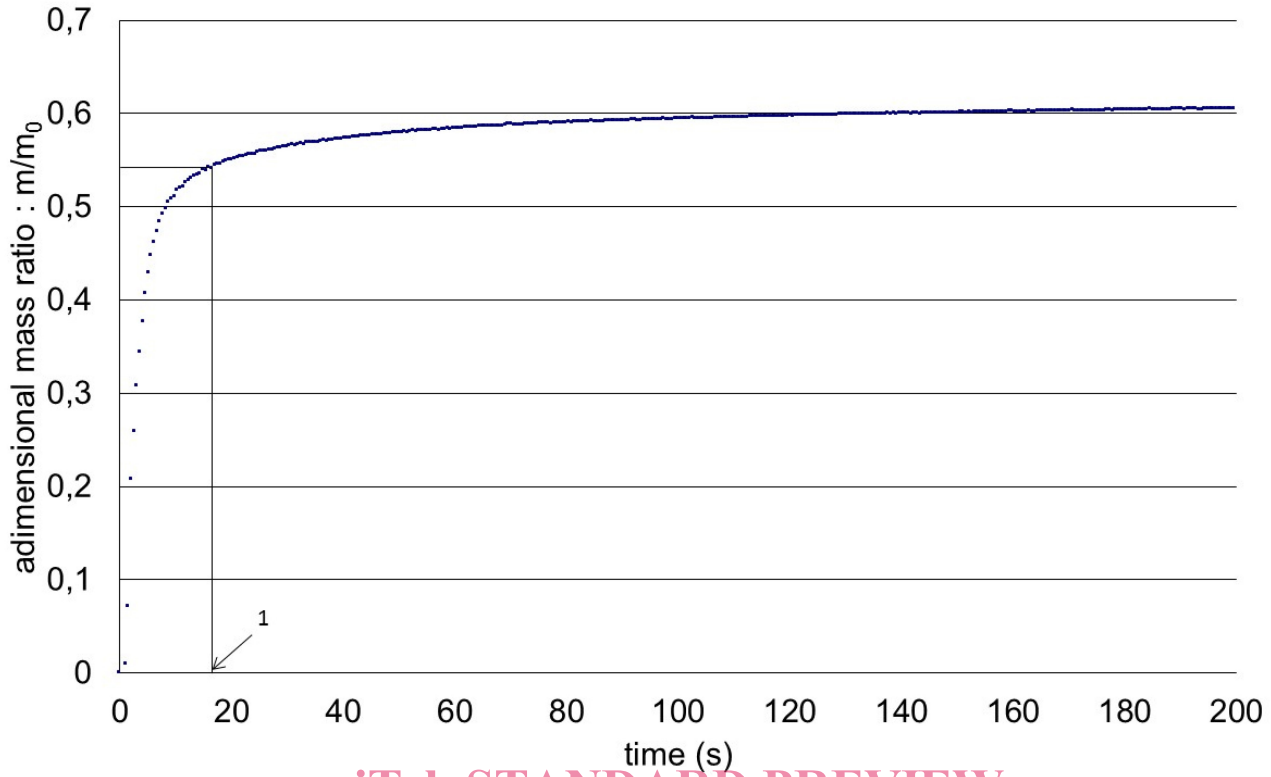
$$P_1 = \frac{Si_f}{Si_0} \tag{2}$$

— Drainage kinetics parameter assessed by the measurement of the time required to recover 90 % of the total mass of filtrate (t_{90}, s) as illustrated Figure 1. An adimensional number was defined by dividing this time (expressed in seconds) by a sizing parameter of belt thickener which is equal to 60 s for classical industrial machines.

$$P_2 = \frac{t_{90}}{60} \tag{3}$$

— The filtrate quality parameter (P_3) defined, as the ratio between the residual concentration of suspended matter in the filtrate (SM_r, %) and the initial solids content of the sludge.

$$P_3 = \frac{SM_r}{Si_0} \tag{4}$$



Key

1 time for 90 % of $(m/m_0)_f$

Figure 1 — Determination of t_{90} with a classical drainage curve

The drainability index (E_g) is expressed by the following formula as discussed in [2]:

$$E_g = \ln\left(\frac{P_1}{P_2^{\alpha} \times P_3^{\beta}}\right) = \ln\left(\frac{\frac{Si_f}{Si_0}}{\left(\frac{t_{90}}{60}\right)^3 \times \left(\frac{SM_r}{Si_0}\right)^{\frac{1}{4}}}\right) \quad (5)$$

NOTE α and β have been chosen by compiling hundreds of data (correlation numbers) and do not result from a theoretical approach.

Annex D gives information about the use of drainability index for drainage process optimization.

10 Test report

The test report shall contain the following information:

a) reference to this document;

b) identification of the sludge (origin, type, identification, concentration, method of sampling and storage);

c) identification of the flocculation conditions and preparation;

d) identification of the operating conditions of the drainability test (initial mass and water content of sludge, reference and supplier of the filtering medium);

e) adimensional mass ratio recovered versus time with at least the volume of filtrate collected at t = 30 s, at t = 90 s and at the end of the test;

f) time (in seconds) corresponding to the collection of 50 % of the initial water content of the sludge;

g) dry mass of the suspended solids, in mg/l;

h) dryness (mass fraction in %) of sludge cake retained on the filtering medium;

i) drainability index;

j) any detail not specified in this document or which are optional and any other factor which may have affected the results.

11 Precision

Full results of validation trials, which 3 types of sludge (i.e. digested sewage sludge, raw sewage sludge, and waterworks sludge) were used for, are reported in Annex C (informative).

All sludge types considered, average values of relative *repeatability* standard deviation were 4,6 % for adimensional mass ratio of filtrate at 30 s, 3,5 % for adimensional mass ratio of filtrate at 90 s, 2,0 % for adimensional mass ratio of filtrate at test end, 20 % for the time to collect 5/10 of sludge water content, 1,8 % for dryness of cake, and 14 % for suspended matter in the filtrate. Minimum value was 1,4 % for dryness of cake of both digested sewage sludge and waterworks sludge, while maximum one was 22 % for the time to collect 5/10 of water content of digested sewage sludge.

All sludge types considered, average values of relative *reproducibility* standard deviation were 4,3 % for adimensional mass ratio of filtrate at 30 s, 3,2 % for adimensional mass ratio of filtrate at 90 s, 2,6 % for adimensional mass ratio of filtrate at test end, 20 % for the time to collect 5/10 of sludge water content, 2,3 % for dryness of cake, and 31 % for suspended matter in the filtrate. Minimum value was 1,0 % for adimensional mass ratio of filtrate at test end of digested sewage sludge, while maximum one was 37 % for suspended matter in the filtrate of raw sewage sludge.

At least the precision data given as averages should be reached in the analysis of sludge.