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BRITISH STANDARD

BS EN
14702-2:2006

Characterization of sludges — Settling properties —

Part 2: Determination of thickenability

The European Standard EN 14702-2:2006 has the status of a British Standard

ICS 13.030.20

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EH/5, Sludge characterization.

A list of organizations represented on EH/5 can be obtained on request to its secretary.

The UK committee has never seen the need to standardize this method at a European level and, as a consequence, has not been actively involved in the development of this standard. However, the UK committee is pleased that a classic British method was selected. The method has long been used as a valuable operational-control method and is available in existing technical literature (see reference [1] in the bibliography of this standard). Due to the difficulty and cost of sending liquid sludge samples (in such a manner that their properties do not change) to laboratories for international interlaboratory trials of the performance of this method, interested parties convened at a workshop to assess the test. Their conclusion was that the results are operationally defined (e.g. by the filter paper used) and, as the document does not specify all such operational details, the performance data are not really applicable outside the context of the workshop. As a result, the members of EH/5 have no information to offer on the reproducibility of the results.

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EUROPEAN STANDARD

NORME EUROPÉENNE

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English Version

Characterization of sludges - Settling properties - Part 2: Determination of thickenability

Caractérisation des boues - Propriétés de sédimentation - Partie 2: Détermination de l'aptitude à l'épaississement

Charakterisierung von Schlämmen - Absetzeigenschaften - Teil 2: Bestimmung der Eindickbarkeit

This European Standard was approved by CEN on 3 February 2006.

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Foreword

This document (EN 14702-2:2006) has been prepared by Technical Committee CEN/TC 308 “Characterization of sludges”, 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 September 2006, and conflicting national standards shall be withdrawn at the latest by September 2006.

Another part of this European Standard is:

— Part 1: Determination of settleability (Determination of the proportion of sludge volume and sludge volume index).

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

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Introduction

Determination of the thickenability, i.e. the further concentration of suspended (undissolved) sludge solids in settling under gravity, through the use of laboratory mechanical assisted cylinders is negatively affected by bridging, wall effects and particle size effects. Ideally, this parameter should be measured in large-diameter columns having the same depth as the prototype thickener, but above effects can be satisfactory overcome by introducing a low-speed stirrer in a cylinder; this also helps to reduce the effect of the shallow depth.

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1 Scope

This document specifies a method for the determination of the thickenability of sludge suspensions. This document is applicable to 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 origin.

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1085:1997 and the following apply.

3.1
thickenability
ability of sludge solids to further concentrate in mechanical assisted settling under gravity

3.2
stirred sludge volume
volume of the sludge suspension after settling under specified stirring conditions

3.3
stirred sludge volume index
quotient of sludge volume by the concentration by mass of dry matter in the sludge, measured in a stirred cylinder

4 Principle

The thickenability is determined by the proportion of the total volume occupied by the sludge in a sludge suspension within 30 min after settling under gentle stirring in standard apparatus and under standard conditions.

5 Interferences

Settling properties vary with the solids concentration. Therefore, the comparison of these properties of sludge suspensions having different solids concentrations is allowed if a reference concentration is assumed; the

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value of 3,5 g/l has been found to be the optimal one [1]. Settling properties evaluated at this solids concentration value also correlate well with the maximum solids loading at which that sludge may be applied to a tank without loss of solids in the effluent.

Interference occurs when there are fairly large temperature differences between the temperature of the sample and the ambient temperature as a result of convection and formation of gas bubbles. With differences of more than 5 °C it is advisable to place the settling cylinder with the sample in a bucket filled with the sample fluid.

6 Apparatus

6.1 graduated cylinder, diameter 10 cm, measuring height 50 cm, nominal volume 3 500 ml, made of glass or transparent plastic, equipped with a low speed stirrer at 1 rpm. The stirrer is in [1] (Annex A (informative)).

6.2 scoop, nominal volume 5 l.

7 Procedure

A representative sample of sludge suspension is taken by the scoop and immediately poured into the graduated cylinder up to the 50 cm mark. For this purpose, a scoop holding 5 l is used. Start the stirrer and record the level of sludge-water interface in the cylinder after 30 min.

For measurements at the reference concentration of 3,5 g/l, sludge samples shall be obtained through dilution by supernatant liquor followed by gentle homogenisation.

8 Expression of results

The stirred sludge volume (V_{ss}) is obtained as the quotient of the sludge volume after stirring (Clause 4) by the volume of the initial sludge sample volume. It is given in millilitres by litre as an average of at least two measurements.

The stirred sludge volume index (I_{ssv}) is calculated from the equation below:

$$I_{ssv} = \frac{1\,000 \times H}{(50 \times C_0)}$$ where

H is the final sludge level in centimetres;

C_0 is the initial solids concentration, in grams per litre (see EN 12880);

50 is the starting height of sludge suspension, in centimetres;

1 000 is a conversion factor.

NOTE For activated sludges, plant values of I_{ssv} at 3,5 g/l lower than 80 ml/g are indicative of good thickenability, while values higher than 120 ml/g of poor thickenability.

9 Precision

Results of validation trials are summarized in Annex B (informative).

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The reproducibility standard deviation ranges from 0,22 ml/g (0,5 %) for digested sewage sludge, to 0,28 ml/g (1,0 %) for waterworks sludge, to 1,03 ml/g (1,1 %) for activated/thickened sewage sludge, and to 1,71 ml/g (1,8 %) for activated sewage sludge.

Mean value is 0,88 ml/g (1,2 %). Minimum precision is 1,8 %.

10 Test report

The test report shall contain the following information:

a) reference to this document;

b) all information necessary for the complete identification of the sludge sample;

c) details of sample preparation; e. g. dilution;

d) results of the determination according to Clause 8;

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

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Annex A
(informative)

Stirred cylinder for determining the thickenability of sludges

The apparatus, as derived from that derived in [1], consists of a graduated transparent cylinder, diameter 10 cm, measuring height 50 cm, equipped with a low-speed stirrer at 1 rpm.

The stirrer consists of two vertical rods, diameter 0,5 cm to 0,6 cm, places asymmetrically to the cylinder axis, the first at a distance from the cylinder wall of about 0,3 cm, the second at a distance from the cylinder wall of about 2,5 cm, with a remaining distance between them of about 5,0 cm.

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Annex B
(informative)

Results of validation trials

Because the circulation of samples of real sludge high in organic content is not possible due to problems associated to changes in their physical characteristics during handling and transportation, the "Modified Round Robin Tests" procedure, developed by TG 3 of CEN/TC 308/WG 1, and reported in doc CEN/TC 308 N 822, was followed. With this procedure, the round robin tests are carried out through "*circulation of analysts*", i. e. operators coming from the laboratories participating to the exercise meet in a common location, close to the place where samples are collected, and work there on same samples, each using own apparatus.

Validation trials were carried out at LUA, Düsseldorf, on 29 September 2004.

Trials involved a total of 11 *Operators* from the following 9 *Laboratories/Institutions* in 3 *Countries*: ARPA Puglia (Bari, I), CEMAGREF (Montaldre, F), CNR-IRSA (Bari, I), Comm. Env. Emerg. in Puglia Region (Bari, I), DIN (Berlin, D), LUA-NRW (Düsseldorf, D), STUA (Lippstadt, D), UBA (Berlin, D), University of Lecce (I).

The following 4 different sludge types were tested:

— **Sample 1**: Sewage sludge – activated
Solids concentration (g/l): 2,71

— **Sample 2**: Sewage sludge – digested
Dry residue (%): 2,21

— **Sample 3**: Waterworks sludge
Dry residue (%): 3,62

— **Sample 4**: Sewage sludge – activated/thickened
Dry residue (%): 0,75

(analyses for measuring solids concentration and/or dry residue were carried out at the Chemical-biological Laboratory of Landeshauptstadt in Düsseldorf)

Test results have been statistically analysed for the evaluation of precision according to ISO 5725-2. In particular, the repeatability standard deviation s_r (for cells containing more than one figure), and the reproducibility standard deviation s_R were calculated.

The tables of results which follow contain the following symbols:

i is the operator number;

j is the level (sample) number;

k (= 1, 2, ..., n) is the test number;

n are the replicates;

n_{ij} is the number of test results in the cell for operator (i) at level (j);

p is the total number of operators (i) (i = 1, 2, …, p);

q are the total testing levels (batches of materials) (j) (j = 1, 2, …, q);

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s_r is the repeatability standard deviation;

s_R is the reproducibility standard deviation;

$\bar{u}_{ij}$ is the cell means;

y is the test result;

y_{ijk} is the result of the test number (k) for operator (i) at level/sample (j).

Table B.1 — Readings

Operator number (i)	Level (j) Sample 1		Level Sample 2		Level Sample 3		Level Sample 4 (= q)	
	values (y_{ijk})	mean ($\bar{u}_{ij}$)	values (y_{ijk})	mean ($\bar{u}_{ij}$)	values (y_{ijk})	mean ($\bar{u}_{ij}$)	values (y_{ijk})	mean ($\bar{u}_{ij}$)
	cm	cm	cm	cm	cm	cm	cm	cm
1	13,0	13,0	49,1	49,1	49,3	49,3	35,4	35,4
2	13,0	13,0	49,0	49,0	49,2	49,2	—	—
3	13,0	13,0	49,0	49,0	49,3	49,3	34,7	34,7
4	13,0	13,0	49,0	49,0	49,0	49,0	—	—
5	13,2	13,2	49,2	49,2	49,4	49,4	35,5	35,5
6	—	—	—	—	49,3	49,3	—	—
7	13,5	13,5	48,9	48,9	49,3	49,3	—	—
8	13,5	13,5	48,5	48,5	49,1	49,1	34,7	34,7
9	13,2	13,2	48,7	48,7	49,6	49,6	35,0	35,0
10 (= p)	13,5	13,5	48,6	48,6	49,4	49,4	34,6	34,6
Mean at level (j)		13,2		48,9		49,3		35,0

NOTE Stirred settling apparatuses used for tests were of the standard Type 305 produced by Triton Electronics, Dunmow, Essex (UK).

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Table B.2 — Stirred sludge volume index, I_{SSV}

Operator number (i)	Level (j) Sample 1		Level Sample 2		Level Sample 3		Level Sample 4 (= q)	
	values (y_{ijk})	mean ($\bar{u}_{ij}$)	values (y_{ijk})	mean ($\bar{u}_{ij}$)	values (y_{ijk})	mean ($\bar{u}_{ij}$)	values (y_{ijk})	mean ($\bar{u}_{ij}$)
	ml/g	ml/g	ml/g	ml/g	ml/g	ml/g	ml/g	ml/g
1	95,94	95,94	44,44	44,44	27,21	27,21	94,41	94,41
2	95,94	95,94	44,35	44,35	27,16	27,16	—	—
3	95,94	95,94	44,35	44,35	27,21	27,21	92,54	92,54
4	95,94	95,94	44,35	44,35	27,05	27,05	—	—
5	97,42	97,42	44,53	44,53	27,27	27,27	94,68	94,68
6	—	—	—	—	27,21	27,21	—	—
7	99,63	99,63	44,25	44,25	27,21	27,21	—	—
8	99,63	99,63	43,89	43,89	27,10	27,10	92,54	92,54
9	97,42	97,42	44,07	44,07	27,38	27,38	93,35	93,35
10 (= p)	99,63	99,63	43,98	43,98	27,27	27,27	92,28	92,28
Mean at level (j)		97,42		44,25		27,21		93,35

Table B.3 — Reproducibility standard deviation, s_R

Sample	s_R	s_R
	ml/g	%
1) Sewage sludge, activated	1,71	1,8
2) Sewage sludge, digested	0,22	0,5
3) Waterworks sludge	0,28	1,0
4) Sewage sludge, activated/thickened	1,03	1,1
Mean value	0,88	1,2

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[1] White, M.I.D., *Instruction Manual for WRC settling operations for activated sludge*, WRC TM 103 (1975).

[2] 91/271/EEC *Council Directive of 21 May 1991 concerning urban waste water treatment, ABl EG, 1991, N° L 135, 40-52*.

[3] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

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