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Čistilne naprave za odpadno vodo - 8. del: Obdelava blata in hranjenje

Wastewater treatment plants - Part 8: Sludge treatment and storage

Kläranlagen - Teil 8: Schlammbehandlung und -lagerung

Stations d'épuration - Partie 8: Stockage et traitement des boues

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Wastewater treatment plants - Part 8: Sludge treatment and storage

Stations d'épuration - Partie 8: Stockage et traitement des boues

Kläranlagen - Teil 8: Schlammbehandlung und -lagerung

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 165.

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

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European foreword

This document (prEN 12255-8:2022) has been prepared by Technical Committee CEN/TC 165 “Wastewater engineering”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 12255-8:2001.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

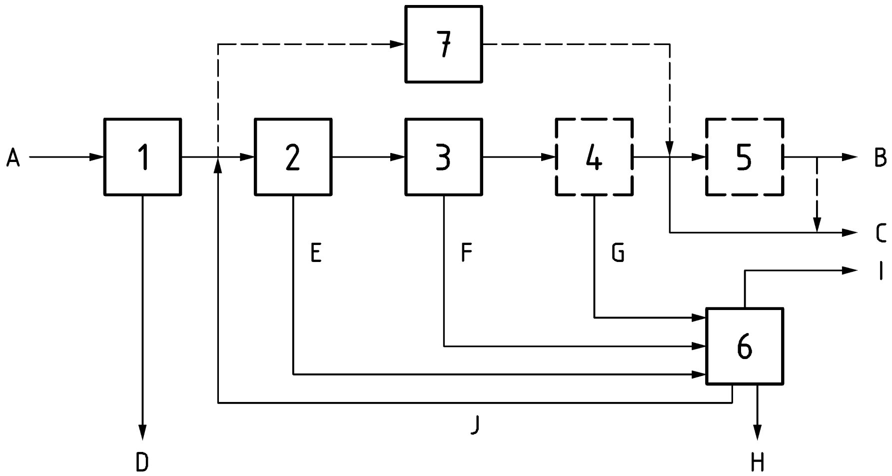
It is the eighth part prepared by Working Group CEN/TC 165/WG 40 relating to the general requirements and processes for treatment plants for a total number of inhabitants and population equivalents (PT) over 50. EN 12255 with the generic title “*Wastewater treatment plants*” consists of the following Parts:

- *Part 1: General construction principles*
- *Part 2: Storm management systems*
- *Part 3: Preliminary treatment*
- *Part 4: Primary settlement*
- *Part 5: Lagooning processes*
- *Part 6: Activated sludge process*
- *Part 7: Biological fixed-film reactors*
- *Part 8: Sludge treatment and storage*
- *Part 9: Odour control and ventilation*
- *Part 10: Safety principles*
- *Part 11: General data required*
- *Part 12: Control and automation*
- *Part 13: Chemical treatment — Treatment of wastewater by precipitation/flocculation*
- *Part 14: Disinfection*
- *Part 15: Measurement of the oxygen transfer in clean water in aeration tanks of activated sludge plants*
- *Part 16: Physical (mechanical) filtration*

NOTE For requirements on pumping installations at wastewater treatment plants see EN 752 and EN 16932 (all parts).

Introduction

Differences in wastewater treatment throughout Europe have led to a variety of systems being developed. This document gives fundamental information about the systems; this document has not attempted to specify all available systems. A generic arrangement of wastewater treatment plants is illustrated below:



Key

1 preliminary treatment
2 primary treatment
3 secondary treatment
4 tertiary treatment
5 additional treatment (e.g. disinfection or removal of micropollutants)
6 sludge treatment
7 lagoons (as an alternative)
A raw wastewater
B effluent for re-use (e.g. irrigation)
C discharged effluent
D screenings and grit
E primary sludge
F secondary sludge
G tertiary sludge
H digested sludge
I digester gas
J returned water from dewatering

Figure 1 — Schematic diagram of wastewater treatment plants

Detailed information additional to that contained in this document may be obtained by referring to the bibliography.

The primary application is for wastewater treatment plants designed for the treatment of domestic and municipal wastewater.

1 Scope

This document specifies design principles and performance requirements for sludge treatment and storage facilities at wastewater treatment plants serving more than 50PT.

Guidance on operation is provided where it is necessary in order to facilitate the design of control and automation and design access to points of operation.

NOTE Other sludges and organic wastes may be treated together with municipal sewage sludge.

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.

<std>EN 12255-1, *Wastewater treatment plants - Part 1: General construction principles*</std>

<std>EN 12255-9, *Wastewater treatment plants - Part 9: Odour control and ventilation*</std>

<std>EN 12255-10, *Wastewater treatment plants - Part 10: Safety principles*</std>

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1
psychrophilic
process conditions for microorganisms which are active below 30 °C

Note to entry: In the context of wastewater applications the effective temperature range for this is higher than given in some other disciplines.

3.2
mesophilic
process conditions for microorganisms which are active at temperatures between 30 °C and 45 °C

Note to entry: in the context of wastewater applications the minimum temperature for this is higher than given in some other disciplines.

3.3
thermophilic
process conditions for microorganisms which are active at temperatures above 45 °C

3.4
pseudo stabilisation
process preventing organic degradation so long as particular conditions (such as pH value-or dryness) are maintained, but for which degradation recommences when the conditions are no longer met

3.5
stock solution
partially prepared mixture of chemical and water in a condition to facilitate handling or distribution

4 Symbols and abbreviations

Abbreviations

BOD_5	biochemical oxygen demand in 5 days
CHP	combined heat and power generating system
CO	carbon monoxide
COD	chemical oxygen demand
d	day
DAF	dissolved air flotation
DD	degree of disintegration (%)
DS	dry solids
EPS	exopolymeric substances
FOG	fat oil and grease
VS	volatile solids
kWh_{el}	kilowatt hours of electrical power
kWh_{th}	kilowatt hours of thermal power
MAP	magnesium ammonium phosphate (struvite)
MSRT	mean solids residence time
N	Nitrogen
NaOH	sodium hydroxide
Nl	normal litre (litre at normal temperature and pressure i.e. at 0 °C and 1013 hPa)
NPSH	nett positive suction head
SVI	sludge volume index
UV –	ultra violet (light)
WAS	waste activated sludge (surplus sludge)
WWTP	waste water treatment plant

Symbols

$C_{Ac,equ}$	volatile organic acids concentration calculated as acetate in mg/l
$C_{COD,0}$	COD concentrations in the sludge water of the untreated sludge in mg/l
$C_{COD,1}$	COD concentrations in the sludge water of the treated sludge
$C_{COD,R}$	reference COD concentration [mg/l]
DD	degree of disintegration (%)
k_H	hydrolysis rate in d^{-1}

t_R	retention time in d
T	temperature in °C
η_{VS}	ratio of degraded volatile solids to initial volatile solids
$\eta_{Dis.COD}$	degree of COD disintegration

5 Planning

Sludge treatment and storage influences subsequent utilization. It may be subject to a variety of regulations dependent upon the site of the treatment plant and the proposed routes for use or disposal.

The choice of the sludge treatment process depends on the size of the treatment plant, the type, origin and characteristics of the sludge to be treated and the final method of utilization or disposal routes and related quality requirements, e.g. nutrients, pollutants, pathogenic microorganisms and caloric value. Processes which allow for more than one sludge utilization or disposal option are preferable.

Consideration should be given to the possibility of centralised sludge treatment facilities which allow a wider range of treatment techniques. Special care is needed in respect of extra loads e. g. of nitrogen generated from sludge liquors at centralised facilities. Sufficient storage capacity shall be available on the source site for raw or treated sludge to prevent sludge overflow under all likely conditions.

The following factors shall be considered in planning sludge treatment:

- sludge characteristics;
- import of sludges and other organic waste;
- utilization or disposal routes and related quality requirements, e. g. nutrients, harmful substances and calorific value;
- minimum and maximum daily sludge production (volume and dry solids mass);
- future sludge production;
- range of solids concentrations (total and volatile solids);
- physical characteristics (e.g. viscosity and temperature);
- biological properties (degradability, inhibitors and toxicants);
- aggressive or corrosive conditions;
- likely emissions including greenhouse gases, pollutants, and odours (see also EN 12255-9);
- removal of gross solids which may cause blockage or malfunction by screening;
- effect of abrasive or deposit forming solids such as grit;
- effect of additives used in wastewater treatment, such as precipitants, coagulants and flocculants and their influence on utilization;
- impact of return liquors on the wastewater treatment process e. g. peak loads of ammonia and phosphorus from sludge processing;

- health and safety of operators and the general public (see also EN 12255-10) e. g. generation of toxic and /or explosive atmospheres;
- noise;
- visual appearance.

The planning stage should include determination of the extent to which the operation of the plants will be automated (see EN 12255-12) as there will be differences between systems designed primarily to operate automatically and those requiring manual intervention. However, all plants shall have provisions for manual intervention in order to safeguard operation in the event of control system failure.

6 Processes

6.1 General

Provision shall be made to allow the sampling of input and output for each unit process (see EN ISO 5667-13).

Flow measurement for each unit process should be considered.

The design shall take account of any requirements for control of odour, noise, vibration and explosive atmospheres in accordance with EN 12255-9 and EN 12255-10.

6.2 Sludge Conditioning

6.2.1 Overview

Sludge needs to be conditioned before thickening and dewatering. The most common conditioning is done with polymers (usually Polyacrylamides), but natural polymers (e.g. based on chitin or potato starch) are also available though they are not as effective. Such natural polymers have the advantage that they are easily biodegradable.

Sludge conditioning can also be achieved with cations such as iron, aluminium and calcium, which achieve coagulation of micro-flocs by compensation of the negative surface charge on particles. Such salts also achieve phosphate precipitation during wastewater treatment. Agglomeration of micro-flocs occurs depending on shear forces, but the resulting flocs are weak. Formation of large and strong flocs requires addition of polymers which form polymer bridges between particles.

Both under- and overdosing of polymers lead to suboptimal thickening and dewatering results. There is a narrow optimum range.

6.2.2 Use of Polymers

Polymers can be distinguished according to their following properties:

- consistency (granular, emulsion or dispersion);
- non-ionic, cationic or anionic (cationic or non-ionic are usually used for sludge conditioning)
- charge density (usually between 20 % and 70 %);
- molecular weight (usually between 10^4 and 10^8 g/mol);
- molecular structure (linear, branched or cross-linked);

- mass ratio of active ingredients (about 95 % for granular products, 25 % to 50 % for emulsions and about 30 % for dispersions)

The storage area for concentrated liquid polymers shall be designed to provide for a maximum storage time of 6 months, because the effectiveness of some polymers deteriorates when they are stored longer. Polymer stations shall be configured to dilute the concentrated polymer to a 0,5 % to 1 % stock solution by intensive mixing into dilution water. Polymer stations shall be designed such that they provide for a ripening time of the stock solution after preparation of at least 45 min before it is used, and a retention time typically between 4 h and 6 h, at most 24 h. Stock solutions shall be kept in untransparent tanks because UV-light can deteriorate them.

Circular vessels for the preparation of stock solutions should have a height to diameter ratio > 1,2. The mixing power should be 1 kW/m^3 to 3 kW/m^3 depending on the vessel's shape and concentration of the stock. For a stock solution viscosity of up to 800 MPa a mixer with one or two axial propellers, having diameters of up to 300 mm, and a rotation speed of 300 rpm to 1 000 rpm should be used. For stock solutions with a viscosity above 800 MPa a both axially and radially driving impeller with a diameter of up to 700 mm and a rotation speed of up to 250 rpm should be used. A distance of the impeller from the wall of 200 mm is recommended to prevent high shear. To prevent vortex formation the mixer should not be located at the centre of the vessel, or rotation reducing baffles should be provided.

The dilution water for the preparation of stock solutions should have potable water quality. Where other water is used, its anion (e.g. chloride, nitrate and sulphate) and its cation (e.g. iron and manganese) concentrations shall be analysed and discussed with suppliers of polymers to establish its appropriateness.".

The dosing concentration of polymers should be between 0,1 % and 0,4 % so that its viscosity is reduced and mixing into the sludge improved. Final effluent may be used for dilution. The use of two variable frequency progressive-cavity pumps is recommended for the stock solution and the dilution water as well as a static inline mixer to mix the two flows. Flow meters for the stock solution and the dilution water are also recommended to control polymer dosage and concentration.

The most efficient units, which can be used for solid and liquid polymers, consist of two batch vessels, the first for preparation and ripening, and the second for storing and dosing the stock solution. There are also units with a single flow-through vessel having three compartments. The latter cannot prevent some short-circuit flow so that the ripening time is not well defined.

Where only liquid polymers are to used, preparation units can be smaller, because their ripening time is shorter. The stock solution can be prepared in a single agitated vessel wherein concentrated polymer is mixed into clean water. The stock solution is then diluted in an inline mixer (see above). However, it is recommended to provide a dosing vessel, or at least space for such a vessel, to provide for additional ripening time.

Polymer stations shall be easy to clean in order to prevent growth of fungi and other germs.

The diluted dosing solution must be rapidly mixed into the sludge, e.g. through a static or dynamic mixer. Dosage into the suction side of a centrifugal pump is also an option. It is recommended to provide two or three dosing points for later optimisation. Polymer is often dosed immediately upstream of centrifuges because the acceleration provides for intensive mixing, though there is little time for floc formation. Prior floc formation would be ineffective because flocs would be damaged by high shear at the entrance into the centrifuge.

With highly effective dynamic mixers, stock solutions with a concentration of up to 0,4 % can be directly mixed into the sludge without the need of further dilution. They consume power, but can save polymer and improve the dewatering result. In addition, the polymer preparation unit is less complex and dilution water is saved. Thinner dosing solutions of polymer will dilute the sludge more than thicker dosing solutions. This added water also has to be removed during sludge dewatering.

After mixing, the conditioned sludge should be subject to gentle shear to provide for good floc formation. This may be done in a gently agitated vessel or in a pipe reactor.

Requirements related to operation:

- operation of the thickening or dewatering machines should end when the reservoir of stock solution is empty because unused stock solution becomes ineffective;
- polymer preparation stations shall be designed for a ripening time of stock solutions of minimum 45 min to guarantee maximum effectiveness of the polymer;
- simple jar tests provide indications for the effectiveness of various kinds of polymer. Laboratory centrifuge or filter tests provide information about optimum thickening or dewatering results. It shall be considered whether such testing equipment should be provided in the plant's laboratory.
- the costs, depending on polymer dosage and dewatering results, should be calculated. These shall include polymer and sludge transport and disposal costs.

Information and recommendations for process checks are provided in Clause A.1.

6.2.3 Polymer storage and distribution

Polymer containers and preparation units shall be installed in intercepting tanks because polymers in concentrations above 0,2 % are water contaminants. The intercepting tanks shall be water-tight, have a sufficiently volume to withhold the maximum leakage volume and be provided with a leak sensor.

Pipelines for polymer solutions shall be either installed above an intercepting tank or shall be double walled with a leak sensor. Polymer solution from the outer pipes shall be drained into intercepting tanks, each provided with a leak sensor.

6.3 Sludge thickening

6.3.1 Process selection

Sludge thickening can be performed in gravity thickeners or dissolved air flotation tanks, or with mechanical thickening equipment such as filters or centrifuges.

The selection of the thickening method and its design shall take account of the following factors:

- the solids concentration required by subsequent processes;
- the required separation ratio, i.e. the maximum allowable solids content in the removed water;
- re-solubilisation of phosphorus in gravity thickeners;
- possibility to control the process;
- ease of operation;
- calculated service life of structures and equipment;
- capital and operation costs.

6.3.2 Gravity thickening

Gravity thickeners can be used for the thickening of primary and/or secondary and tertiary sludge. They can also be used for the thickening of digested sludge. However, they shall not be used for the thickening of WAS from activated sludge systems with enhanced biological phosphorus removal because WAS releases phosphates under anoxic and anaerobic conditions which would be returned to the system.

Gravity thickeners can be operated continuously or in batch mode depending on the size of the plant.

Gravity thickeners should have a depth of at least 3 m, have a bottom slope of at least 50° (conical) or 60° (pyramidal) to the horizontal, or shall be equipped with either an agitator or a rake with a bottom scraper (e.g. a picket fence).

They should be provided with a sensor determining the upper level of the consolidating sludge to permit a high sludge level while preventing sludge overflow.

Other features to be considered include:

- retention time; when it is longer than a day, hydrolysis and acidification can begin causing odour emission, foaming, sludge bulking and impaired dewaterability; however, hydrolysis may be desired upstream of anaerobic digestion;
- controlled sludge feeding and decanted sludge water removal;
- retention and removal of scum;
- supernatant withdrawal at different levels (e. g. using a vertically moveable device);
- means permitting observing the quality of the supernatant liquor during removal;
- ventilation and exhaust air deodorisation if thickeners are covered.

Factors affecting the design of gravity thickeners include:

- the surface flow rate (≤ 0,75 m/h);
- the surface mass loading rate (up to 100 kg/(m²·d) for primary sludge, 40 kg to 80 kg/(m²·d) for mixed sludges, and 20 kg to 50 kg/(m²·d) for WAS depending on its sludge volume index;
- the solids retention time (usually ≤ 1,5 d);
- the depth of the consolidation zone (≈ 2 m).

The following solids concentrations may be expected:

- primary sludge: 3 % to 6 %
- mixed sludge: 2 % to 5 %
- WAS, dependent on its SVI: 1 % to 3 %

(higher concentrations are possible with polymer addition)

- anaerobically digested mixed sludge: 3 % to 5 %

Gravity thickeners for anaerobically digested sludge can also be used for intermediate sludge storage and may have a retention time of several days. They shall be provided with gas-tight covers and shall be connected with the digester gas system in order to prevent emission and permit use of the released methane, a greenhouse gas that has global warming potential 25 times stronger than carbon dioxide.