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Čistilne naprave za odpadno vodo - 6. del: Postopek z aktivnim blatom

Wastewater treatment plants - Part 6: Activated sludge process

Kläranlagen - Teil 6: Belebungsverfahren

Stations d'épuration - Partie 6: Procédé à boues activées

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13.060.30	Odpadna voda	Sewage water

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Wastewater treatment plants - Part 6: Activated sludge process

Stations d'épuration - Partie 6: Procédé à boues activées

Kläranlagen - Teil 6: Belebungsverfahren

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European foreword

This document (EN 12255-6:2023) has been prepared by Technical Committee CEN/TC 165 “Waste water Engineering”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by January 2024, and conflicting national standards shall be withdrawn at the latest by January 2024.

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 12255-6:2002.

This is the sixth 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.

The EN 12255 series 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 treatment*
- *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 Part 2 is under preparation.

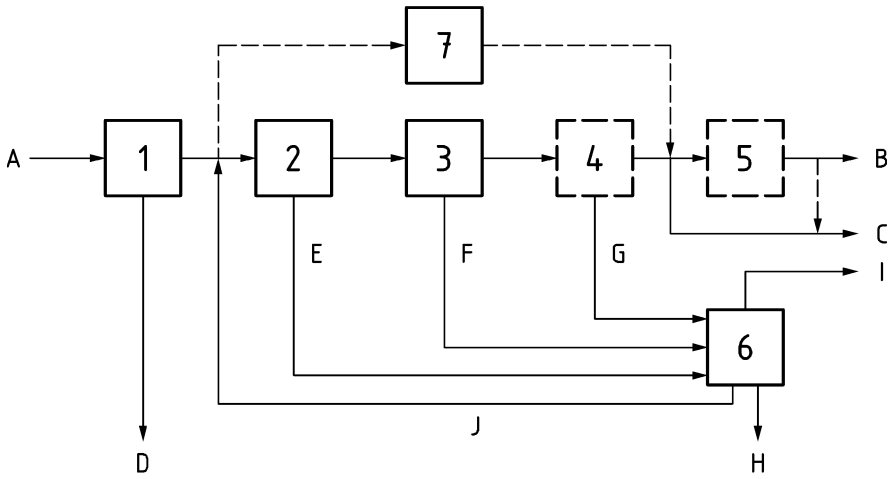
NOTE For requirements on pumping installations at wastewater treatment plants see EN 752, *Drain and sewer systems outside buildings — Sewer system management* and EN 16932 (all parts), *Drain and sewer systems outside buildings — Pumping systems*.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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

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 in Figure 1:



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

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

NOTE For requirements on pumping installations at wastewater treatment plants see EN 752, *Drain and sewer systems outside buildings*, and EN 16932, *Drain and sewer systems outside buildings — Pumping systems*:

— *Part 1: General requirements;*

— *Part 2: Positive pressure systems;*

— *Part 3: Vacuum systems.*

1 Scope

This document specifies performance requirements for treatment of wastewater using the activated sludge process for plants over 50 PT.

The informative Annexes A to W provide design information.

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 16323, *Glossary of wastewater engineering terms*

EN 12255-1, *Wastewater treatment plants - Part 1: General construction principles*

EN 12255-10, *Wastewater treatment plants - Part 10: Safety principles*

EN 12255-11, *Wastewater treatment plants - Part 11: General data required*

EN 12255-12, *Wastewater treatment plants - Part 12: Control and automation*

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 terminology databases for use in standardization at the following addresses:

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

3.1
enhanced biological phosphorus removal
activated sludge system for increased biological phosphorus removal by luxury uptake whereby mixed liquor or return sludge is intermittently subjected to anaerobic and aerobic conditions

3.2
internal recirculation ratio
IRR
ratio of the flow of recirculated nitrate containing wastewater to a denitrification reactor relative to the inflow

3.3
selector
first, optional reactor of an activated sludge system where incoming wastewater and return activated sludge are blended and mixed to subject the return activated sludge to a high sludge load in order to mitigate sludge bulking

Note 1 to entry: A selector can be aerobic or anaerobic; aerobic selectors are more common. An anaerobic selector can also be used to assist biological phosphorus removal.

3.4
mixed liquor suspended solids
MLSS
dry mass concentration of suspended solids in a mixed liquor

[SOURCE: EN 16323:2014, definition 2.3.10.24]

Note 1 to entry: The dry mass of filtered solids is determined in accordance with the 23rd edition of Standard Methods for Wastewater (SMEWW), 2540 parts D & E.

3.5
mixed liquor volatile suspended solids
MLVSS
dry mass concentration of organic suspended solids in a mixed liquor

[SOURCE: EN 16323:2014, definition 2.3.10.25]

Note 1 to entry: The dry mass of filtered solids is determined in accordance with the 23rd edition of Standard Methods for Wastewater (SMEWW), 2540 parts D & E.

4 Symbols and abbreviations

4.1 Symbols

Symbol	Definition	Unit
A	area	m^2
C	mass concentration	mg/l
D	diameter	m
OUR_{spec}	oxygen uptake rate per person (specific oxygen consumption)	kg/(P·d)
f_U	utilization factor (see EN 12255-1)	(dimensionless)
F/M	load (food to mass ratio), (e.g. kg (BOD_5/d) per kg MLSS)	kg/(kg·d)
HRT	hydraulic retention time (= V/Q)	d or h
IRR	internal recirculation ratio (for recirculation of nitrate)	(dimensionless)
L	length	m
$MASRT$	aerobic sludge age = mean aerobic solids retention time	d
$MSRT$	sludge age = mean solids retention time	d
OC	oxygen (transfer) capacity	kg/h
OC_{spec}	specific oxygen consumption per person	kg/(P· d)
OTE	oxygen transfer efficiency at operational conditions	kg/kWh
P	power	W or kW

Symbol	Definition	Unit
PT	total population (= population + population equivalents)	P
Q	flow	m^3/h or l/s
Q_{spec}	specific flow per person	$m^3/(P \cdot h)$
RSR	return sludge ratio = return sludge flow to wastewater inflow	(dimensionless)
SOTR	standard oxygen transfer rate in clean test water	kg/h
SSOTR	specific standard oxygen transfer rate in clean test water per standard volume of air	$g/(Nm^3 \cdot h)$
SOTE	standard oxygen transfer efficiency in clean test water	kg/kWh
SSOTE	specific standard oxygen transfer efficiency in clean test water (percent of supplied oxygen transferred per immersion depth)	%/m
SSP	surplus sludge production	kg/d
SSP_{spec}	specific surplus sludge production per person	$g/(P \cdot d)$
SVI	sludge volume index	ml/g
SSVI	stirred sludge volume index	ml/g
T	temperature	°C or K
V	volume	m^3
W	width	m
Y	yield (generated biomass per mass of substrate)	kg/kg
a_S	number of scraper arms	-
b	degradation rate	d^{-1}
c	molar concentration	mol/m^3
f	factor	(dimensionless)
h	height or depth	m
l	load per person and day	$g/(P \cdot d)$
m	mass	g or kg
n	number of scraper arms or diffusers	—
p	pressure	Pa, hPa or kPa
q	specific flow relative to x	$m^3/(h \cdot x)$
t	time	d, h or s
v	velocity	m/s

Symbol	Definition	Unit
α	alpha factor = ratio of oxygen transfer coefficients in wastewater to clean test water	(dimensionless)
β	salinity factor of clean test water	(dimensionless)
Δp	pressure loss	Pa or kPa

4.2 Indices (not included in the symbols or abbreviations below)

Al3	trivalent aluminium (Al^{3+})
aer	aeration
alk	alkalinity
atm	atmospheric (ambient)
B	bottom
BioP	enhanced biological P removal
Bl	blower
BM	biomass
Cla	clarifier
cy	cycle
Deg	degraded or degradable
del	delay (times for raising and lowering a scraper blade)
Den	denitrification
des	design
Dif	diffuser
dis	dissolved
Dos	dosing
DS	dried solids
eff	effective
Fe	iron
Fe2	bivalent iron (Fe^{2+})
Fe3	trivalent iron (Fe^{3+})
geo	geodetic (vertical level)
h	hourly
im	immersion
in	incoming
inert	not degradable
inorg	inorganic
int	intermittent aeration

intD	intermittent denitrification
kLA	oxygen transfer coefficient
max	maximal
min	minimal
Nitr	nitrification
org	organic
out	outgoing
part	particulate
PL	Pipeline
PostD	post-denitrification
PreD	pre-denitrification
prec	precipitated
Proc	process
R	reactor
redeg	readily degradable
ret	returned
S	scraper
Sal	salinity
Sat	saturation
SC	shortcut
Scr	scraper
SE	scraper effectiveness
SimD	simultaneous denitrification
Spec	specific (related to x)
St	standard
TW	test water

4.3 Abbreviations

Al	aluminium
BOD_5	biochemical oxygen demand in 5 days
C	carbon
CH_4	methane
CO_2	carbon dioxide
COD	chemical oxygen demand
DS	dried solids
EPDM	ethylene-propylene-dien class M, a synthetic rubber material

Fe	iron
H_2S	hydrogen sulfide
MAP	magnesium ammonium phosphate (struvite)
ML	mixed liquor
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
N	nitrogen
NH_4	ammonium
NO_3	nitrate
N_2O	nitrous oxide (laughing gas)
orgN	organic nitrogen
O_2	oxygen
P	phosphorus
PE-HD	polyethylene with high density
PP	polypropylene
PT	total population
PVC	polyvinylchloride
RS	return sludge
SBR	sequencing batch reactor
TKN	total Kjeldahl nitrogen
TSS	total suspended solids
WWTP	wastewater treatment plant

5 Requirements

5.1 General

Biological reactors and final clarifiers are connected by return sludge recirculation lines and form a unit process: the activated sludge process. The performance of the process depends on biological and chemical reactions in the activated sludge tanks as well as separation of activated sludge in the final clarifiers. Activated sludge systems include structures, such as aeration basins and sedimentation tanks, and technical equipment, such as aeration systems and sludge scrapers.

Biological treatment and clarification (decanting) may be combined in a single sequencing batch reactor (SBR) with intermittent aeration and sedimentation.

The design shall take account of the requirements specified in EN 12255-1, EN 12255-10, EN 12255-11 and EN 12255-12.

Annexes A, B and C provide typical design values, typical wastewater characteristics and usual primary settling tanks' effectiveness.

5.2 Planning

5.2.1 Basic information

The design of an activated sludge system may be based on common values as provided in Annex B, in particular for plants serving up to 1 000 PT. For larger plants, the design should be based on the following information (ideally maximum or minimum 2 weeks average over 2 to 3 years):

1. Maximum and minimum wastewater temperature and temperature-dependent requirements on the effluent quality;

2. Maximum, minimum hourly flow and yearly average wastewater inflow; and the maximum 2 h-inflow during dry weather conditions;

3. System loads, depending on primary treatment (where provided), including variations of COD (or BOD_5), TSS, P and TKN concentrations. The 85 %-quantiles should be provided for system design and the 50 %-quantiles (i.e. medians) or arithmetic averages should be provided for the calculation of operating costs and the design of sludge treatment facilities;

4. Where possible, the composition of the incoming COD shall be provided to the designer, separated into degradable dissolved COD, inert dissolved COD, degradable particulate COD, inert particulate COD and readily degradable COD; See Annex C for more information.

   NOTE With the standard methods, COD is analysed using dichromate as the oxidising agent. Chromium is a heavy metal. It would be more sustainable if dichromate could be replaced with a different oxidising agent.

5. A minimum of 40 samples should be analysed for all parameters. For plants serving less than 10 000 PT the number of samples may be less.

6. The consent standards concerning COD, N and P concentrations in the effluent.

Return loads from sludge treatment shall be taken into account, particularly ammonium return load. In some cases, it may be necessary to provide separate treatment of filtrate or centrifugate from sludge dewatering, e.g. using a de-ammonification process.

Load removal ratios during primary treatment shall be taken into account. It is recommended to investigate the removal ratios during dry weather conditions. Where this is not feasible, removal ratios as shown in Annex C may be used.

Biological treatment units should be protected from excessive hydraulic loads e.g. by the use of overflow devices and/or storm tanks to meet the required discharge consent. The frequency and volume of wastewater discharges should be limited (see EN 752).

If the waste water composition is unusual, it is recommended that a half-technical pilot test is performed for a minimum period of half a year (including the cold weather period) to investigate data for the system design. A design based on long-term testing can optimize the design and avoid safety factors necessarily included in a more general design.

Where the required sample analysis is not feasible, Annex A provides basic guidance information for system design.

The following factors shall be determined during planning of an activated sludge system:

- capacity and dimensions of the biological reactors;

- prevention of dead zones and of detrimental deposition in tanks/channels;