Wastewater treatment plants —

Part 7: Biological fixed-film reactors

The European Standard EN 12255-7:2002 has the status of a British Standard

ICS 13.060.30

National foreword

This British Standard is the official English language version of EN 12255-7:2002.

The UK participation in its preparation was entrusted to Technical Committee B/505, Wastewater engineering, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 165, Wastewater 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of an identical text or by endorsement, at the latest by July 2002, and conflicting national standards shall be withdrawn at the latest by December 2002.

It is the seventh part prepared by the Working Groups CEN/TC 165/WG 42 and 43 relating to the general requirements and processes for treatment plants for a total number of inhabitants and population equivalents (PT) over 50. The parts of the series are as follows:

— *Part 1: General construction principles*

— *Part 3: Preliminary treatment*

— *Part 4: Primary settlement*

— *Part 5: Lagooning processes*

— *Part 6: Activated sludge processes*

— *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*[1)]

NOTE For requirements on pumping installations at wastewater treatment plants, provided initially as Part 2*, Pumping installations for wastewater treatment plants*, see EN 752-6, *Drain and sewer systems outside buildings — Part 6: Pumping installations*.

The parts EN 12255-1, EN 12255-3 to EN 12255-8 and EN 12255-10 and EN 12255-11 were implemented together as a European package (Resolution BT 152/1998).

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

[1)] In preparation.

1 Scope

This European Standard specifies the design principles and performance requirements for secondary treatment by biological fixed-film reactors at wastewater treatment plants for more than 50 PT.

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

Biological fixed film reactors include biological trickling filters, rotating biological contactors, submerged bed reactors and biofilters.

Differences in wastewater treatment throughout Europe have led to a variety of systems being developed. This standard gives fundamental informations about the systems; this standard has not attempted to specify all available systems.

Detailed information additional to that contained in this standard may be obtained by referring to the Bibliography.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 752-6, *Drain and sewer systems outside buildings — Part 6: Pumping installations.*

EN 1085, *Wastewater treatment — Vocabulary.*

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

EN 12255-6, *Wastewater treatment plants — Part 6: Activated sludge processes.*

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

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

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1085 and the following apply.

3.1
wastewater dose
volume of wastewater discharged on to a trickling filter from a single pumping cycle or a single siphoning from a filter dosing chamber

3.2
flushing intensity
surface hydraulic loading rate divided by the number of arms of a rotary distributor and divided by the number of revolutions per hour

NOTE This value gives information on the hydraulic forces to wash excess sludge out of the bed.

3.3
submerged bed reactor
bed of packed or suspended inert media which is typically open structure plastic and is submerged in the flow to allow the active biological film attached to the media to purify the wastewater

NOTE A clarifier can be required.

4 Requirements

4.1 General

4.1.1 Biological fixed film processes

Biological fixed film processes may include:

- trickling filters;
- rotating biological contactors;
- submerged bed reactors;
- biofilters.

Biological fixed-film processes can treat the following types of influent:

- primary treated wastewater;
- finely-screened or sieved wastewater;
- effluent from secondary treatment.

These are processes in which support media is used to support growth of a film of microorganisms which flocculate and biodegrade soluble, colloidal and suspended matter in wastewater.

The processes can operate under aerobic and/or anoxic or anaerobic conditions and provide intimate contact between influent and the biological film. Solids present in treated effluent should be removed before final discharge.

In the case of biofilters the solids are retained within the reactors.

4.1.2 Trickling filters

In trickling filters, wastewater is distributed over and percolates down through a bed of support media, contacting the biological film growing on the surface of elements of the media. The bed shall contain continuous open spaces between elements of support media to promote natural or induced ventilation. Operating conditions on the bed shall support the growth of larger organisms such as protozoa and macro-invertebrates, often termed “grazing organisms”, to control the growth of biological film and reduce surplus sludge. Humus tanks should be used to clarify wastewater discharged from the filter.

4.1.3 Rotating biological contactors

A rotating biological contactor consists of discs or packs of support media, which are arranged along a shaft and are partially immersed in wastewater.

The shaft rotates, enabling biological film, which grows on the support media, to alternately contact wastewater and air and bring about treatment. Performance can be improved by adopting the principle of a plug flow system. Rotating biological contactors may be supplied either as stand-alone biological treatment units or as package plants, incorporating primary and secondary settlement zones. Plant shall be designed to ensure that sludge flows to points that provide practical access for its removal.

4.1.4 Submerged bed reactors and biofilters

In these reactors, wastewater flow should be uniformly distributed through a submerged bed of support media. Air utilized for aeration should be supplied by a blower and distributed from pipework. The design of the aeration systems should distribute the air evenly over the fixed bed.

Denitrifying submerged bed reactors shall have a system for controlling deposits of sludge accumulating on the bottom or inside the bed of media.

In submerged bed reactors using an open structure media backwashing is not required, as the excess sludge is removed by aeration. Backwashing is typically required if media of a granular type is used.

Carbonaceous oxidation, nitrification and denitrification can be carried out in single or separate stages of biofiltration as well as achieving suspended solids removal.

Biofilters may be designed for upward or downward flow of wastewater. They may be required to be taken out of service for backwashing or may operate continuously with a separate washing system. The media may be single or multi-layer and can have a specific gravity greater or lower than that of water.

4.2 Planning

The following factors shall be considered in the design:

- characteristics of incoming wastewater;
- the capacity and dimensions of the biological reactors;
- the prevention of dead zones and detrimental deposition in tanks/channels;
- the establishment of multiple lines/units or other technical means to ensure maintenance of required final effluent quality if one or more line/unit is out of operation;
- the surface area, volume and depth of the clarifiers where used;
- the treatment and final destination of the sludge produced;
- the head loss to be minimized;
- measurement and control;
- media specification.

Reference should be made to EN 12255-1, EN 12255-6, EN 12255-10 and EN 12255-11 for further considerations.

4.3 Process

4.3.1 Design

The following operational parameters shall be considered and shall be appropriate for the type of treatment required:

— volumetric loading rate [kg/(m^3 ·d)] (as BOD_5, COD, NH_4-N or NO_3-N);

— mass surface loading rate [kg/(m^2·d)] (as BOD_5, COD, NH_4-N or NO_3-N);

— support media specific surface (m^2/ m^3);

— recirculation ratio;

— surface loading rate [m^3/(m^2· h)];

— flushing intensity (mm);

— interval between backwashing (biofilters).

NOTE The references in the Bibliography give further information.

4.3.2 Modes of operation

The plant may be configured in one of the following modes:

— single stage treatment in which the wastewater passes through only one reactor followed by clarification;

— two stage treatment in which the wastewater passes through two reactors in series and which can include clarification after both stages or only after the second stage;

NOTE Biofilters do not require intermediate or final clarification.

— alternating double filtration in which the sequence of flow through trickling filters is alternated so that each set of filters treat in successive periods either settled wastewater or effluent from the first stage. This limits excessive growths of biological film, which might otherwise develop in the upper layers of the first stage trickling filter when treating a high strength wastewater.

The types of treatment that may be provided are as follows:

— carbonaceous oxidation;

— nitrification, which occurs after carbonaceous removal and is achieved by operating plant either at a lower loading rate or using a separate stage;

— denitrification, which is typically established in a two stage step system, where the first stage step is used for denitrification and the second stage for BOD removal and nitrification. These flow schemes need a recycle of nitrified wastewater from the effluent of the second step to the influent of the first step. Simultaneous nitrification and denitrification in a one step system requires a specific design and operation of the aeration. To achieve downstream denitrification a supplementary carbon source will be required;

— phosphorus removal, which in fixed-film processes can be carried out by precipitation using chemical agents. To avoid any accumulation of precipitates in the biofilm dosing points should be installed at the inlet to the final clarifier;

— phosphorus removal can also be achieved in a biofilter.

Recirculation may be employed to:

- dilute influent to prevent excessive growths of biological film in the surface layers of trickling filters;
- increase the hydraulic loading rate to improve the efficiency of wetting in trickling filters and encourage transfer of biological film growth from upper to lower levels in a bed;
- provide adequate flushing intensity.

NOTE Recirculation is normally achieved by pumping of the treated wastewater (see EN 752-6).

4.3.3 Selection of support media

Support media shall have an extensive surface area to support the growth of biological film and hence maximize treatment performance. Sufficient space shall be provided between surfaces of adjacent elements of media to allow excess biological film growth sludge to be removed from, and unrestricted wastewater and air to flow, through the bed.

Support media may be made from the following materials:

- graded crushed mineral;
- plastics in the form of regular size and shape and randomly arranged;
- plastic sheets or tubes assembled as modules to give a lightweight support media with a voidage of 90 % or higher.

The support media shall have the following properties:

- durability to withstand weathering and exposure to sunlight;
- suitable surface to support attachment of biofilm;
- durability to withstand chemical attack from wastewater constituents;
- non-biodegradable.

For submerged bed reactors and biofilters the media shall be resistant to abrasion.

Plastic media shall be resistant to structural deformation from applied loads.

The specific surface area used in fixed-film processes without backwashing shall be selected due to the required type of wastewater and desired process efficiency. For high rate processes in trickling filters and submerged bed reactors and first sections of submerged bed reactors the specific surface area should not exceed 100 m^2/m^3. For rotating biological contactors the specific surface area should not exceed 150 m^2/m^3 in the first high-loaded sections. For simultaneous BOD removal and nitrification or nitrification alone in trickling filters and in last sections of submerged bed reactors the specific surface area of media should not exceed 200 m^2/m^3. For rotating biological contactors it should not exceed 250 m^2/m^3.

For submerged bed reactors in which the media is suspended the specific surface area should not exceed 1 000 m^2/m^3.

The designer shall select the loading parameter appropriate to the type of biological fixed-film process and use a value pertaining to the influent quality, climatic conditions and effluent quality that is required.

4.3.4 Dimensions

The number of units and their plan area shall be selected taking account of the following criteria:

a) Trickling filters

For ease of flow distribution these should preferably be circular. Where land space is limited rectangular designs may be considered. Unless otherwise agreed, at all but the smallest sites there should be at least two units to give standby capacity in case of failure. Owing to limitations of distributor design, the diameter of circular filters should not exceed 50 m.

The depth of media should be selected depending on the site application and the process requirements, e.g. available hydraulic head. Secondary trickling filters designed to give full treatment to wastewater should be between 1,8 m and 7,0 m deep. High rate filters designed for partial treatment and nitrifying filters can be between 4,0 m and 7,0 m deep. For package trickling filter plants serving small populations (e.g. 51 PT to 100 PT) depths may be as low as 0,6 m.

Using the plan area derived from the volume of media and the selected depth and the value for the daily flow rate of wastewater, the designer shall ensure that the surface hydraulic loading is sufficient to ensure that each element is sufficiently wetted to promote biofilm growth throughout the bed. The designer shall select a depth, a suitable rate of recirculation and speed of rotation of a distributor and its design, to achieve a sufficient flushing force for efficient operation of the filter.

b) Rotating biological contactors

The disc or packs of media typically have diameters in the range of 1m to 5 m with shaft lengths of up to 10 m. The shaft deflection on full operating load, where the rotor is completely blocked with biomass, shall be no greater than 1/300th of its length.

Tank volume of rotating biological contactors should provide either a minimum retention time of 1 h at maximum flow or 4 l/m^2 of media surface.

c) Submerged bed reactors and biofilters

The depth of bed in these reactors is typically between 2 m and 10 m. The depth of bed of biofilters may be 2 m to 4 m.

4.3.5 Flow distribution

All biological plants shall allow a uniform distribution of flow to the support media.

a) Trickling filters

In trickling filters flow distribution can be provided by static distributors employing spray nozzles or splash plates, or moving distributors. Rotary distributors are used for circular filters and travelling distributors are used for rectangular filters.

Rotary distributors shall be designed to give a uniform wetting rate to the filter surface. Because a rotating bar covers more surface area on moving away from the centre of rotation, the quantity of irrigation should increase in this direction. This can be arranged by increasing the number of points of discharge per unit length of the distributor arm at greater radii.

For efficient operation under intermittent dosing a minimum of one dose per 30 min is essential to ensure that none of the biomass dries out.

b) Rotating biological contactors

The inlet and outlet should be positioned at opposite ends of the rotating biological contactor, and in a manner to promote flow of influent through the rotating assembly and thereby prevent short-circuiting.

c) Submerged bed reactors

Aerated fixed-film systems may operate in upflow or downflow configurations. Anoxic systems need specific design to avoid short-circuiting.

d) Biofilters

Adequate flow distribution between filter units shall be provided. Sufficient wastewater entry points and/or discharge points shall be provided to ensure satisfactory flow distribution within the bed of media.

4.3.6 Oxygen supply

Trickling filters shall be provided with an underdrainage system which allows the unimpeded flow of treated wastewater away from the process. This system shall also provide free access of air to the base of the support media for ventilation. Additional vertical pipes may be incorporated into the bed of media to enhance ventilation. For high-rate filters, the environmental impact arising from odours should be minimized by employing forced ventilation using a fan, enclosing the filters and ducting off gases to an odour treatment facility.

Rotating biological contactors rely on free access of air to the biological films attached to the media. Covers shall be designed for ease of access and shall not restrict the required flow of air.

Submerged bed reactors and biofilters shall have sufficient aeration capacity to meet the peak load. The density of air entry points shall be sufficient to provide an even distribution into the media. Some designs can provide aeration at a single point and then circulate the aerated wastewater through the media to provide the desired distribution.

NOTE Aeration can also be used to scour excess biomass from the support media.

4.3.7 Clarification and solid separation

Trickling filters, rotating biological contactors and submerged bed reactors should be provided with a subsequent clarification stage to remove settleable solids from the effluent. Biofilters are backwashed and normally do not require subsequent clarification.

In addition to the type of process planned and the required efficiency of separation, the sizing parameters also depend on the type of clarifier, and notably the minimum settling rate of the sludge. This rate takes into account the specific hydraulic characteristics of both upward flow and horizontal flow clarifiers, whether or not they are equipped with lamella modules.

The clarifier(s) shall be deep enough to retain sludge under maximum flow rates.

The upflow velocity of effluent within a clarifier shall be less than the lowest settling velocity of the solids to be settled.

The design of clarifier and sludge removal equipment shall be suitable to prevent resuspension of solids.

Further design considerations may be found in section 4.4 and in EN 12255-6.

Clarification may also be performed by drum filters, grass plots, soil irrigation or lagoons.

Backwash water generated by biofilters may be returned to the primary settlement stage or treated separately.

4.3.8 Additional considerations

Biological treatment should be protected from excessive hydraulic loads e.g. by the use of overflow devices and/or storm tanks to meet the required discharge standard.

Flow balancing can improve the level of performance, particularly the degree of nitrification.

A fine screen should be used to prevent large solids blocking distribution systems or the media.

The plant should be designed to prevent the accumulation of sludge within the bed of media for the following reasons:

- prevention of septicity;
- impairment of treatment efficiency;
- prevention of odours;
- structural overload.

4.4 Detailed design

4.4.1 Structures

The structures shall be designed so as to withstand all potential mechanical stresses of operation.

a) Trickling filters

The structural design of the walls and the base shall withstand the complete water pressure caused by clogging of the support media, except for those support media where clogging is not possible or the structure is not retentive.

Where mineral media are used, stresses generated in the wall by settlement during seasonal expansion and subsequent contraction of the structure shall be taken into account.

b) Rotating biological contactors and submerged bed reactors

The design of the tank should be such as to minimize the build up of sludge solids and provide sufficient rigidity so as not to impair the functioning of mechanical equipment during operation.

c) Biofilters

Where the design incorporates a perforated false floor, which supports the media and forms a bottom plenum chamber, this shall take account of potential pressures on the structure during operation and backwashing.

d) Clarifiers

The inlet zone shall be designed to ensure dissipation of energy and an even distribution of flow.

The settling zone shall be designed to ensure a sufficient surface area and depth for the settlement of humus sludge and to minimize short-circuiting.

The effluent collection zone shall be designed to ensure:

- uniform and slow draw-off of effluent from the settling zone;
- retention of the facility for the removal of floating sludge and other matter;
- minimum sludge carry over.

The collection and removal of sludge shall be arranged according to the size and type of clarifier. Where a hopper is installed the angle of slope of the sides measured from the horizontal shall not be less than 50° for conical and 60° for pyramidal hoppers.

For small units, sludge may be collected by gravity flow, by means of steeply inclined (50° to 60°) floors and as smooth a surface as possible.

For larger clarifiers with flat or slightly inclined floors, a scraping or removal device is necessary such as one of the following:

— scraper blades to move sludge towards a point in the centre (circular structure) or at the edge (rectangular structure), with multiple hoppers;

— sludge sucked from the bottom of the clarifier by siphons or pumps which are fixed to travelling bridges.

The removal device shall be designed to ensure rapid sludge recovery to avoid anaerobic conditions. The velocity of the scraping device where used shall be low enough to minimize turbulence.

4.4.2 Mechanical and electrical equipment

Unless otherwise agreed the design service life of the equipment shall be:

— Class 3: for motors, geared engines and drive chains;

— Class 4: for central bearings of any rotary distributor;

— Class 5: for the bearings of rotating biological contactors.

a) Trickling filters

Rotary distributors are usually hydraulic reaction driven or electrically driven. The holes in distributor arms shall be a minimum of 20 mm diameter. This may be reduced if fine screening is incorporated. Removable end caps shall be included at the ends of distributor arms to facilitate the clearing of blockages.

b) Rotating biological contactors

The rotating biological contactor rotor assembly shall withstand the maximum design load generated when the void-space is partially filled with biological film. In addition, motors, gear boxes and bearings shall be able to withstand the significant out-of-balance forces that can develop when a rotor and associated biological film is left stationary for any length of time in its normal, partially-submerged state.

The bearings of rotating biological contactors shall be capable of tolerating misalignment of up to 5 mm/m length of shaft.

c) Submerged bed reactors and biofilters

Backwashing is carried out using treated effluent often assisted by air to scour the bed. Treated effluent for backwashing should be stored in a tank. Backwashing may be carried out on a time interval and/or head loss basis. When carried out on a time basis, backwashing should be initiated when head loss exceeds a critical level.

When a treatment unit is taken out of service, the other units shall be capable of taking the extra load and maintaining the required performance. Where backwashing is not continuous, a balancing tank for sludge liquors should be provided.

A backwashing programme is necessary as air and backwash water may be used separatly or in combination during separate phases of the backwashing process. The programme for a multi-layer filter shall achieve both the cleaning of the bed and classification of the individual filter layers. With a continuous flow filter such a programme is not necessary as a portion of the media is transferred to a separate washing system.

Bibliography

The following documents contain details which can be used within the framework of this standard.

This list of documents which are published and used by the members of CEN was correct at the time of publication of this European Standard but should not be considered to be exhaustive.

Austria

[1] OENorm B 2502-1, *Domestic sewage treatment plants for buildings up to 50 inhabitants — Appliance, dimensioning, erection and operation.*

[2] OENorm B 2502-2, *Small sewage treatment plants — Installations for buildings of 51 to 500 population equivalents — Application, dimensions, construction and operation.*

[3] VORNORM OENORM B 2505-2, *Bepflanzte Bodenfilter (Pflanzenkläranlagen)-Anwendung, Bemessung, Bau und Betrieb.*

[4] OWAV – RB 23, *Geruchsemissionen aus Abwasseranlagen.*

France

[5] Ministere de l'équipment, du logement et des transports (96-7 TO*); Conception et exécution d'installations d'épuration d'eaux usées*, Fascicule n° 81 titre II.

Germany

[6] DIN 19569-8, *Sewage treatment plants — Principles for the design of structures and technical equipment — Part 8: Specific principles for the equipment for sewage treatment in granular fixed bed filters.*

[7] ATV-A 122, *Principles for dimensioning, construction and operation of small sewage treatment plants with aerobic biological purification stage for connecting values between 50 and 500 total number of inhabitants and population equivalents* [2)].

[8] ATV-A 135, *Principles for the dimensioning of biological filters and biological contactors with connection values over 500 population equivalents* [2)].

[9] ATV-A 257*, Dimensioning principles for sewage oxidation ponds and in-line biological filters or contact aerators* [2)].

[10] ATV-Handbuch: *Biologische und weitergehende Abwasserreinigung*, Verlag Ernst & Sohn, Berlin und München, 4. Auflage 1997.

Switzerland

[11] VSA-Richtlinie, *Kleinkläranlagen — Richtlinie für den Einsatz, die Auswahl und die Bemessung von Kleinkläranlagen* (1995).

United Kingdom

[12] BS 6297 (amended 1990), *Code of practice for design and installation of small sewage and treatment works and cesspools.*

[2)] Available at: Gesellschaft zur Förderung der Abwassertechnik e. V. (GFA), Theodor-Heuss-Allee 17, 53773 Hennef.

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National Annex NA (informative)

Design and loading data

NA.1 Introduction

Clause **4** of the standard gives guidance on the design of trickling filters, rotating biological contactors and submerged fixed-bed reactors (or biofilters) so as to highlight the main design considerations for each type of process. This annex gives more detailed information on the typical loading rates used for design of each process type depending on the main modes of operation.

Further information may be obtained from the Manual of British Practice on Biological Filtration [1] and the Handbook of Wastewater Practice for Tertiary Treatment [2]. The design of trickling filters or rotating biological contactors to serve population equivalents of 1 000 or less is considered in more detail by the British Standard for the design and installation of small sewage treatment works [3].

Suitable gradings of mineral medium for use in trickling filters is given in the British standard on media for biological percolating filters [4]. For installation of plastics media, manufacturers should be consulted.

Typical loading rates are based on treatment of domestic wastewater at the normal range of temperatures in the UK (from 6 ºC in the winter up to 18 º in the summer). Lower loading rates may be required, if wastewater:

- contains significant levels of trade waste which inhibit biological treatment;
- has below average temperatures;
- is derived from a sewerage system subject to high levels of saline intrusion;
- has seasonal variations in flow and load.

NOTE In all cases the actual loading rate will depend on the effluent quality required. Nutrients may need to be added if they are deficient at sites where wastewater contains a significant proportion of trade waste or arises from a catchment with soft water.

NA.2 Trickling filters

Table NA.1 — Typical loading rates for trickling filters

Treatment required	**Type of process**	**Support media specific surface** m^2/m^3	**Volumetric loading rates**		**Surface loading rate** $m^3/m^2 \cdot h$
			kg BCD/$m^3 \cdot d$	kg NH_4-N/$m^3 \cdot d$	
Partial treatment	High rate	40 to 100	0.5 to 5	—	0.2 to 2
Carbonaceous oxidation/ nitrification	Low rate	80 to 200	0.05 to 5	0.01 to 0.05	0.03 to 0.1
Tertiary nitrification	Low rate	150 to 200	<40 mg BOD/l[a]	0.04 to 0.2	0.2 to 1

[a] Concentration in plant influence.

NA.3 Rotating biological contactors

Table NA.3 — Typical loading rates for rotating biological contactors

Treatment required	Type of process	First-stage mass surface loading rate kg/m²·d[a]	Average mass surface loading rate kg/m²·d
Partial treatment	High rate	≤ 0.04	≤ 0.01
Carbonaceous oxidation	Low rate	≤ 0.03	≤ 0.005
Carbonaceous oxidation/ nitrification	Low rate	≤ 0.03	≤ 0.002

[a] Where a unit is baffled into stages the loading rate on the first stage should be less than the recommended value to prevent excessive film growth and minimise odours.

NA.4 Submerged fixed-bed reactors

Table NA.4 — Typical loading rates for submerged fixed-bed reactors

Treatment required	Type of process	Volumetric loading rates	
		Kg BOD/m³·d	Kg NH_4-N/m³·d
Carbonaceous oxidation	High rate	2 to 5	—
Carbonaceous oxidation/ nitrification	High rate	0.5 to 2	0.1 to 0.4
Tertiary nitrification	High rate	< 20 mg BOD/l[a]	0.2 to 1.0

[a] Concentration in plant influent.

NA.5 Humas tanks

Depending on the required clarification efficiency, the maximum surface loading rate should not exceed a value of between 1 and 1.5 m³/m²·h. The maximum retention time at peak flow should be 2 h. For scraped tanks, floor slopes normally range from 14º to 6º.

List of references

[1] Manuals of British Practice in Water Pollution Control. *Unit Processes Biological Filtration*. 1988. The Institution of Water and Environmental Management.

[2] Handbooks of UK wastewater practice. *Tertiary treatment* (second edition). 1994. The Institution of Water and Environmental Management.

[3] BS 6297 (amended 1990), *Code of practice for design and installation of small sewage and treatment works and cesspools*.

[4] BS 1438 (amended 1980), *Specification for media for biological percolating filters*.

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