International Standard

ISO 9784

Guidelines for biological filtration of secondary effluent for water reuse

Lignes directrices relatives à la filtration biologique de l'effluent secondaire pour la réutilisation de l'eau

First edition
2024-10

Reference number
ISO 9784:2024(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 General **2**
4.1 Overall recommendations 2
4.2 Basic process 3
5 Process components **4**
5.1 Biofilter unit 4
5.2 Mixing unit 4
5.3 Backwashing unit 4
5.4 Controlling unit 4
6 Technical recommendations of the biofilter unit **4**
6.1 Filter media 4
6.2 Water and air distributor zone 5
6.3 Configuration of the biofilter unit 5
7 Technical recommendations of the mixing unit **6**
8 Technical recommendations of the backwashing unit **6**
8.1 Backwashing mode 6
8.2 Equipment 7
9 Technical recommendations of the controlling unit **7**
9.1 Monitoring instrumentation 7
9.2 Monitoring system 7
9.3 Control system 7
10 Post-treatment process **7**
11 Water reuse applications **8**
Annex A (informative) **Example structure diagrams of BAF and DNF** **9**
Annex B (informative) **Cases of water reuse application using biological filtration for secondary effluent treatment** **12**
Annex C (informative) **Autotrophic denitrification** **16**
Bibliography **17**

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 282, *Water reuse*, Subcommittee SC 2, *Water reuse in urban areas.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Global water consumption has been increasing by approximately 1 % annually since the 1980s, due to population growth, socio-economic development and changing consumption patterns. It is expected that global water demand will keep increasing at a similar rate, and that by 2050 the water use will have increased by 20 %-30 % compared to the current level[9]. Water reuse is an efficient measure to alleviate the global water shortage problem and is a common action for many countries in the world. “Fit for purpose” is a consensus in the field of water reuse, which reduces the demand for fresh water by reusing secondary effluent in different scenarios, such as urban miscellaneous water, circulating cooling water, process and product water, etc. Treated secondary effluent acts as an important source of water supply, providing opportunities to strengthen traditional water supply in some cities, particularly where long-distance transfers are required to meet water demands. Organics and nitrogen in wastewater are the key indicators for the management and control of water reuse in various countries.

Biological filtration, as a mainstream technology for wastewater treatment and reuse, is widely used for advanced treatment of secondary effluent to achieve the effective removal of carbon, nitrogen and solid substances. However, due to differences in technological, economic, social and environmental conditions, there is no unified guideline on technical recommendations for biological filtration on a global scale. This hinders the effective application of biological filtration as a “fit for purpose” practice to treat secondary effluent.

Guidelines for biological filtration of secondary effluent for water reuse

1 Scope

This document provides guidance for biological filtration of secondary effluent for water reuse. It specifies general recommendations, process components and technical recommendations of each component, post-treatment process and water reuse applications.

This document is applicable to all types of stakeholders involved in implementing biological filtration for advanced treatment of secondary effluent for water reuse.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

— IEC Electropedia: available at https://www.electropedia.org/

3.1
biological filtration
wastewater treatment process depending on the physical filtration of the *filter media* (3.7) filled in the treatment infrastructure and the biochemical action of the biofilm attached to the filter media

3.2
biofilter
bed of inert *filter media* (3.7) with large holes through which wastewater is caused to percolate for the purpose of purification by means of an active biological film (bacteria bed) on the inert filter media

Note 1 to entry: Also known as biological filter.

[SOURCE: ISO 6107:2021, 3.72, modified — The preferred term has been changed from “biological filter” to “biofilter”; Note 1 to entry has been modified.]

3.3
biological aerated filter
BAF
combination of contact oxidation and filtration by means of artificial aeration, intermittent backwashing and other measures, aiming to remove organic pollutants, ammonium nitrogen and suspended solids

3.4
backwash rate
flow rate of backwashing water or backwashing air passing through *filter bed* (3.6) per unit area per unit time

Note 1 to entry: Backwash rate is generally represented as $m^3/(m^2 \cdot h)$.

3.5
denitrification filter
DNF
biofilter (3.2) for the purpose of denitrifying nitrate nitrogen in wastewater

3.6
filter bed
filter that consists of layers of *filter media* (3.7) arranged over one another so that a liquid flowing through one filter media does not carry it into the next to clog it

Note 1 to entry: Also known as graded filter.

[SOURCE: ISO 6707-1:2020, 3.3.4.45, modified — The preferred term “graded filter” and the admitted term “leaching field” have been removed; in the definition, “coarse gravel, coarse sand, and fine sand” has been changed to “filter media”; Note 1 to entry has been added.]

3.7
filter media
materials used in the *filter bed* (3.6), such as coarse gravel, fine gravel, ceramsite, coarse sand and fine sand serving as support for microorganisms’ adhesion and growth, and also with the function of physical interception and filtration for suspended solids in supplied water

3.8
graded gravel layer
granular material layer which is laid between the water distribution system and the *filter bed* (3.6), to prevent the *filter media* (3.7) from leaking into the water distribution system

3.9
heterotrophic denitrification
process by which bacteria convert nitrate nitrogen into nitrogen and other gases using organic matter (such as methanol, acetic acid, sodium acetate, etc.) as energy and electron donor

3.10
volumetric nitrogen loading rate
amount of nitrogen (such as ammonium nitrogen and nitrate nitrogen) removed per cubic meter of *filter bed* (3.6) per unit time

Note 1 to entry: Volumetric nitrogen loading rate is generally expressed as kg N/(m^3·d).

4 General

4.1 Overall recommendations

The general recommendations for applying biological filtration of secondary effluent for water reuse are as follows.

a) Biological filtration is applicable for the treatment of both raw wastewater and secondary effluent of municipal wastewater treatment plants. Also, it is suitable for the biological treatment of industrial wastewater with water quality characteristics similar to those of municipal wastewater.

b) Biological filtration can be applied alone or integrated with other wastewater treatment technologies. The selection of biological filtration should be based on different considerations of influent water quality and treatment, along with comprehensive analysis of technical, economic and environmental factors.

c) The construction of biofilters should be based on topographic, meteorological, geological conditions, operation and environmental safety factors. Measures should be especially taken to avoid freezing, odour, flies and corrosion.

d) The form and flow direction of the corresponding reactors of the biological filtration systems should be designed and selected according to different influent water quality and treatment considerations.

4.2 Basic process

Possible process flow diagrams for applying biological filtration for carbon and NH_3-N (ammonium nitrogen) removal, total nitrogen removal of effluent containing NH_3-N and nitrate nitrogen removal are shown in Figure 1, Figure 2 and Figure 3, respectively. Possible structure diagrams of biological aerated filter (BAF) (one/two stages) and denitrification filter (DNF) are also given in Annex A.

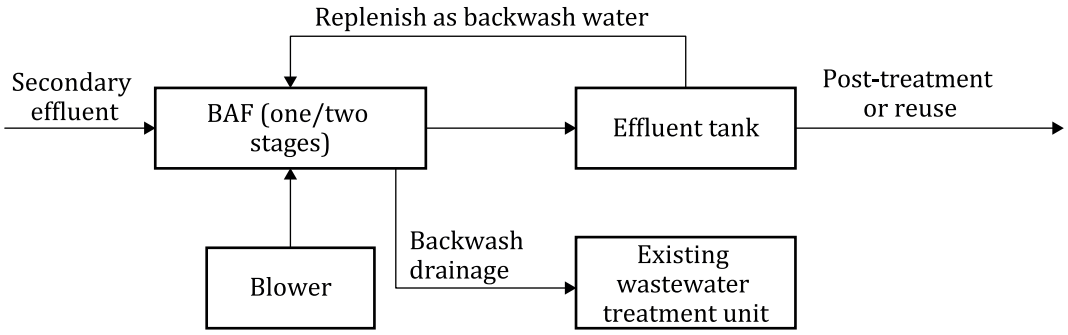

Figure 1 — Possible process flow diagram for applying biological filtration for carbon and NH_3-N removal from the secondary effluent

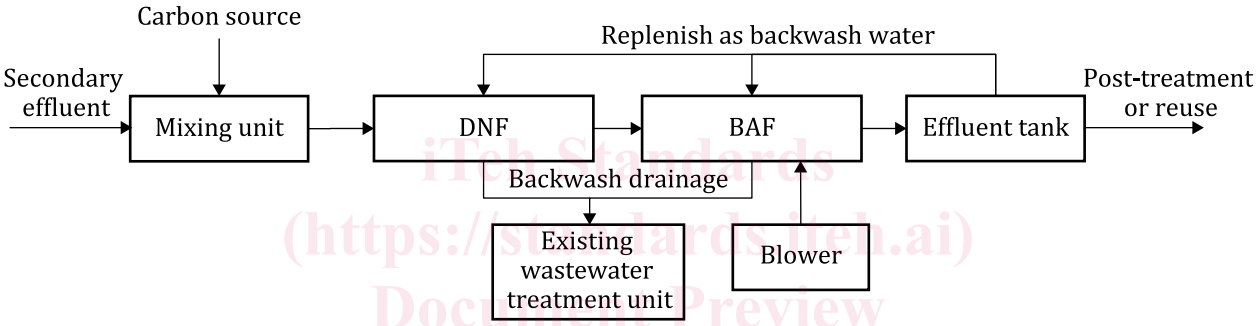

Figure 2 — Possible process flow diagram for applying biological filtration for total nitrogen removal from the secondary effluent containing NH_3-N

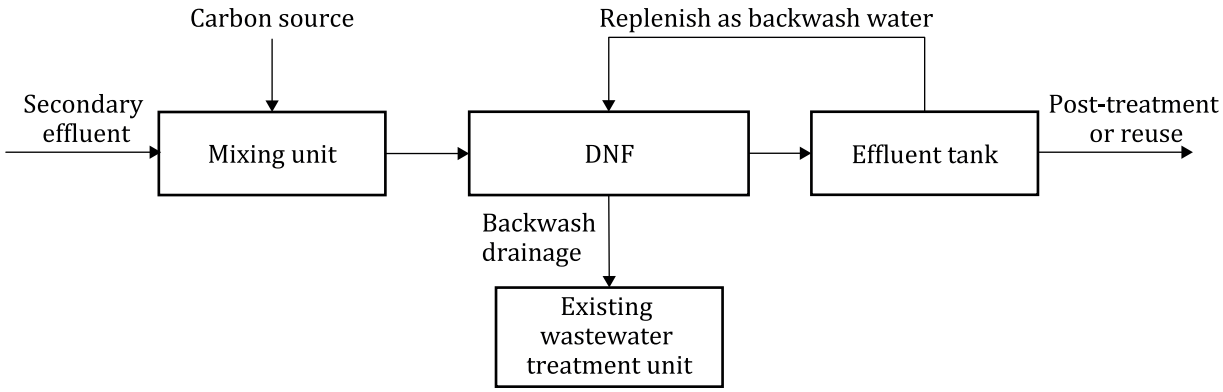

Figure 3 — Possible process flow diagram for applying biological filtration for nitrate nitrogen removal from the secondary effluent

5 Process components

5.1 Biofilter unit

The components of the biofilter unit (BAF and DNF) that should be considered are shown in Table 1. Possible structure diagrams for BAF and DNF are shown in Annex A.

Table 1 — Major components of the biofilter unit

Components	BAF	DNF	
		Upflow	Downflow
Influent distribution area	✓	✓	—
Water inlet ditch	—	—	✓
Water and air distributor	✓	✓	✓
Graded gravel layer	✓	✓	✓
Filter bed	✓	✓	✓
Process aeration system	✓	—	—
Backwash drainage ditch	✓	✓	✓
Water outlet system	✓	✓	✓
Automatic control system	✓	✓	✓

5.2 Mixing unit

The purpose of the mixing unit is to mix secondary effluent and external carbon source from the carbon source dosing tank.

5.3 Backwashing unit

The backwashing unit is mainly comprising backwash water pump and blower.

5.4 Controlling unit

When applying biological filtration, automatic control systems for centralized and decentralized controlling should be adopted. The control of related equipment is generally set up on-site, by programmable logic controller (PLC) and central control room.

6 Technical recommendations of the biofilter unit

6.1 Filter media

Filter media can be made of the following materials:

— graded crushed mineral (e.g. quartz sand);

— granular activated carbon;

— mineral beads or granules (e.g. ceramsite);

— particulate matter containing reduced sulfur and iron for autotrophic or combined heterotrophic and autotrophic denitrification to save external carbon sources;

— foamed beads (e.g. foamed ceramics);

— plastics of regular size and shape (e.g. polypropylene ball);