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Biological equipment for treating air and other gases — Requirements and application guidance for deodorization in wastewater treatment plants

Équipements biologiques pour le traitement de l'air et autres gaz — Guide d'application pour la désodorisation dans les stations d'épuration des eaux usées

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Foreword

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This document was prepared by Technical Committee ISO/TC 142, *Cleaning equipment for air and other gases.*

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Introduction

There are tens of thousands of wastewater treatment plants (WWTPs) running worldwide, most of which produce odour gas as secondary pollution. The typical contaminants in odour gas include hydrogen sulfide, ammonia and volatile organic compounds (VOCs). Besides, hydrogen sulfide in odour gas can also lead to severe corrosion on structure and pipeline and increases the risk of accidental poisoning.

Among different techniques, biological techniques have been recognized as a cost-effective and most applied method for WWTPs deodorization. Biological methods treat the odour gases through microbial metabolism. Their advantages are low operational cost, simple to operate, very safe to use and having lower secondary pollution levels. The typical biological equipment includes biofilter, biotrickling filter and bioscrubber. The biological techniques were used for about 70 years to effectively treat the odour gas emitted from WWTPs. A great amount of experience has been gathered on biological equipment from work carried out on numerous sites around the world. However, the biological odour gas treatment facilities varied greatly from case to case, both in configuration and performance.

Therefore, it is necessary to develop a standard at the international level by collating the successful experiences together and providing a guidance for the installation and application of biological odour treatment equipment worldwide.

Biological equipment for treating air and other gases — Requirements and application guidance for deodorization in wastewater treatment plants

1 Scope

This document specifies the requirements and application guidance for biological deodorization systems in wastewater treatment plants (WWTPs). The specific requirements include odour gas characterization, process selection, equipment manufacture and installation, start-up and operation, performance evaluation, security and secondary pollution control.

The guidance can help the development and maintenance of biological deodorization systems in WWTPs and benefits the owners and operators of WWTPs.

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
wastewater treatment plant
WWTP
plant that purifies wastewater with physical, chemical, biological methods or a combination of those to make the discharge conform to the requirements of discharge standards or the need for environmental protection

3.2
odorant
substance which has the potential to get volatilized and stimulate a human olfactory system so that an odour is perceived

Note 1 to entry: Typical odorants in WWTPs include sulfur-containing compounds (hydrogen sulfide, organic sulfides), nitrogen-containing compounds (ammonia, amines) and volatile organic compounds (VOCs).

3.3
odour gas
waste gas containing odorants emitted from industrial, civil or domestic processes

3.4
odour source in WWTPs
structure or equipment emitting odour gases in a wastewater treatment plant

Note 1 to entry: In WWTPs, the primary odour source includes the wastewater pre-treatment units, anaerobic treatment units and waste sludge treatment units. Sulfides including hydrogen sulfide are the typical odorants from the raw wastewater. Sulfides, ammonia and VOCs are the typical odorants from the waste sludge. The emission increases where there is turbulence or disturb in the wastewater or waste sludge.

3.5
odour concentration
quantitative indicator of odour intensity through tests with olfactory organs

Note 1 to entry: The value of odour concentration is the diluted multiples of the odour gas samples to the detection threshold value of panellists using clean air.

Note 2 to entry: The odour concentration of the raw odour gas varies greatly from case to case and is affected by odorants emission rate and configuration of collection system. Odour concentration can be measured according to different methodologies such as ASTM D 1391, EN 13725 or GB/T 14675-93.

Note 3 to entry: The odour concentrations measured by different methods cannot be compared directly.

3.6
bioreactor for deodorization
biological reactors used to treat odour gases collected from different odour sources to minimize the emission of odorants

Note 1 to entry: Biological reactors for waste gas treatment are typically biofilm reactors with microbial colonies immobilized on the surface of packing media, such as a biofilter or a trickling biofilter. The other type of biological reactors are suspended-growth reactors with the microbial populations suspended in a liquid medium, such as a bioscrubber. For WWTPs applications, biofilters and trickling biofilters are much more applied than bioscrubbers.

3.7
biofilter
bioreactor treating waste gas with the aid of biofilm attached to the packing media which moisture is maintained by a prepositive humidifier or intermittent water feeding to the filter bed

Note 1 to entry: The typical packing media employed are organic or/and inert materials randomly packed in the filter beds.

3.8
trickling biofilter
biotrickling filter
bioreactor treating waste gas with free moving liquid layers on the surface of inert packing media to supply nutrients, take away metabolites or control pH for the biofilm attached to the packing media

Note 1 to entry: The typical packing media employed are inert materials randomly or structured packed in the filter beds.

Note 2 to entry: External nutrients addition is required when the packing media cannot offer enough nutrients for the growth of microorganism.

3.9
bioscrubber
absorber transferring contaminants from waste gas to liquid absorbent, and removing the dissolved contaminants by suspended-growth microorganisms in a supplementary space

Note 1 to entry: The built-in device of the scrubbing unit can be a bulk or structured packing or a construction with plates or a rotating disk.

Note 2 to entry: External nutrients addition is usually required.

Note 3 to entry: Pre-humidification is not required.

3.10
filter bed
bed including the packing media and the microorganisms on the surface of packing media

Note 1 to entry: The typical packing media employed are natural or/and artificial materials randomly or structured packed.

Note 2 to entry: The typical microorganisms are bacteria or/and fungi in form of biofilm on the surface of the packing media or free cells in the liquid.

Note 3 to entry: Odour gas passes through the filter bed and gets purified by mass transfer and biological degradation of odorants.

3.11
superficial velocity
volumetric odour gas flow rate divided by the free cross-section area of the bioreactor column, with unit in m/s or m/h

3.12
empty bed residence time
EBRT
total volume of the filter bed divided by the odour gas flow rate

Note 1 to entry: Unit is in s.

3.13
odorant removal efficiency
E
ratio of odorant concentration reduction and inlet odorant concentration

Note 1 to entry: Removal efficiency is also referred to as elimination efficiency.

3.14
odorant removal rate
r
amount of odorants removed by a unit volume of packing material in a unit time

Note 1 to entry: Removal rate (*r*) is also referred to as elimination capacity (EC) or elimination rate (ER).

Note 2 to entry: It is generally used to evaluate the capacity of the reactors for odorant removal. It is very relevant and useful for the comparison of various bioreactors. It is important to note that *E* is dependent upon the inlet odorant concentration or EBRT of a bioreactor.

Note 3 to entry: The maximum removal rate is the maximum value of instantaneous elimination capacities in

$g/(m^3 \cdot h)$ while increasing the inlet loading.

3.15
pressure drop
difference in static gas pressure between the inlet and outlet of the equipment

Note 1 to entry: The pressure drop of the bioreactor and odour gas collection duct will affect the energy consumption of the blower and its operational costs. The pressure drop of the bioreactor is mainly decided by the character of the filter bed and the superficial velocity.

4 Odour gas characterization and process design

4.1 Odour gas characterization

4.1.1 The main odour sources in WWTPs are covered and the odour gases emitted from different sources predominantly are collected by a pipeline system. The bioreactor for deodorization is installed at the end of the pipeline system and treats the total mixture of odour gases. In some cases, with small flow rates but high odour concentrations, a separate treatment unit for this source can be useful.

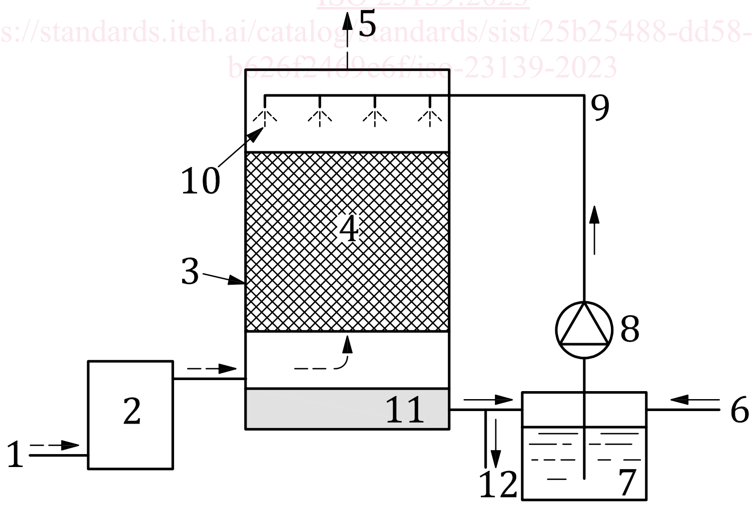
4.1.2 The characteristics of the odour gas include the flowrate, the odorants component and concentration in the odour gas, emission rate of odorants, the temperature and the relative humidity etc. The characteristics of the odour gas affect the design and operation of the odour gas collection and treatment system. An adequate and precise characterization on odour gas helps to achieve better performance and less cost.

4.1.3 When the odour gas collection pipeline system is installed, the characteristics of odour gas can be measured on-site at specific points of the pipeline system.

4.1.4 When there is no gas collection pipeline system, the emission rates (in $g/(m^2 \cdot h)$) of odorants can be measured by using a flux chamber or wind tunnel on the surface of wastewater (referring to EN 13725 for example). For WWTPs not installed yet, the references on previous similar applications are also needed.

4.2 Process design

4.2.1 The biological deodorization process can include some pre-treatment units and a biological reactor in series as illustrated in Figure 1.



Key

1	odour gas	7	water tank
2	pre-treatment unit	8	pump
3	bioreactor column	9	pipeline
4	filter bed	10	spray nozzle
5	treated gas	11	leachate
6	added water	12	drainage

Figure 1 — Scheme of a biological deodorization equipment