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Faecal sludge treatment units — Energy independent, prefabricated, community-scale, resource recovery units — Safety and performance requirements

Unités de traitement des boues de vidange — Unités préfabriquées et autonomes en énergie de récupération de ressources à l'échelle locale — Exigences de sécurité et de performance

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Foreword

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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).

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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.

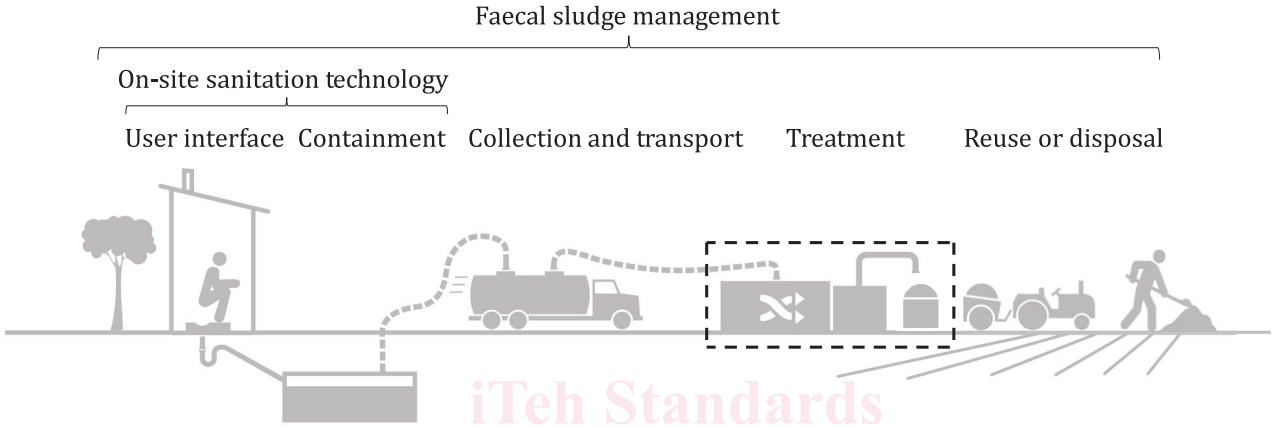
This document was prepared by Project Committee ISO/PC 318, *Community scale resource-oriented sanitation treatment systems*.

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

Hygienic sanitation systems are crucial for public health, yet 61 % of the global population do not have access to safely managed sanitation services; that is, excreta safely treated in situ or treated off-site.

Safe and sustainably managed sanitation improves health and welfare and is fundamental to human development. Integrated business models and technologies throughout the sanitation value chain (see Figure 1) can ensure the economic viability of processes that turn waste into valuable resources, such as renewable energy by-products (e.g. electricity, biofuels, or briquettes) or agriculture products. Safely managed sanitation systems can also prevent contamination of water sources, thus leading to livelihood improvements.



NOTE Treatment is the focus of this document (depicted in the dashed box).

Figure 1 — Sanitation value chain

As shown in Figure 1, this document focuses on non-sewered faecal sludge treatment units with the purpose to specify performance and safety requirements of community-scale resource recovery faecal sludge treatment units serving approximately, but not limited to, 1 000 to 100 000 people. It aims to specify technical requirements and recommendations for such treatment units in terms of performance, safety, operability and maintainability.

This document is intended to ensure the performance, safety, and sustainability of community-scale resource recovery faecal sludge treatment units as well as technical robustness and safety in terms of human health and the environment.

It further aims to promote trust among the different stakeholders involved in faecal sludge management, such as investors, technology developers, government officials, regulatory bodies, local service providers, and users, increasing their willingness to implement innovative new technologies. Manufacturers and technology developers can use this document to gain consumer confidence in the reliability and safety of treatment units. Stakeholders can use this document as a benchmark to compare performance capabilities of different treatment unit options and identify which option is most suitable for their needs.

Faecal sludge treatment units — Energy independent, prefabricated, community-scale, resource recovery units — Safety and performance requirements

1 Scope

This document specifies requirements and test methods to ensure performance, safety, operability and maintainability of community-scale resource recovery faecal sludge treatment units (herein addressed as treatment units) that serve approximately, but not limited to, 1 000 to 100 000 people. This document applies to treatment units that:

a) primarily treat faecal sludge,

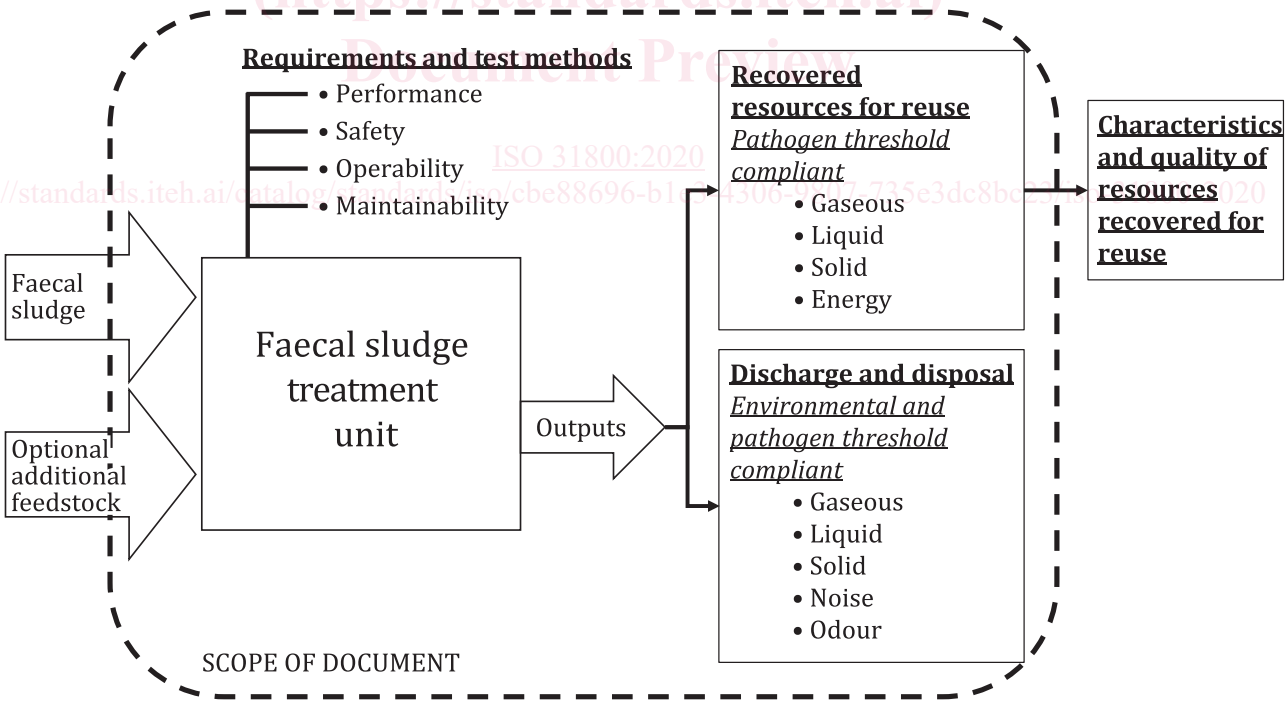
b) are able to operate in non-sewered and off-grid environments,

c) are prefabricated,

d) exhibit resource recovery capability (e.g. recovering energy, reusable water, soil amendment products), and are capable of being energy neutral or energy net positive.

This document does not apply to treatment units requiring major sewer infrastructure.

Figure 2 illustrates the scope of this document with respect to treatment unit inputs and outputs.



Key

--- boundary of the scope of this document

Figure 2 — Scope of this document

Inputs are primarily faecal sludge derived from human excreta and can include additional substances at the discretion of the manufacturer. This document does not specify the characteristics of the faecal

sludge (e.g. COD, BOD, moisture content, etc.) and which forms of the additional inputs (e.g. food waste) are treated within the unit. These inputs are defined by the manufacturer as well as the input characteristics which meet the requirements specified in this document.

This document addresses:

— the performance, safety, operability, and maintainability of the treatment unit,

— the protection of human health and the environment,

— safety aspects of the treatment unit's solid, liquid, and gaseous outputs,

— noise and odour outputs of the treatment unit.

This document specifies minimum requirements of all types of outputs from the treatment unit. It does not specify or mandate the quality of resources recovered as these are highly dependent on the local (e.g. economic, social) context.

Any resources produced and consumed internally to the process itself are outside the scope of this document. Similarly, with the exception of pathogen requirements, the quality and value of any resource recovery and reuse products derived from the treatment unit are outside the scope of this document. Apart from the requirement for energy independence under manufacturer specified input conditions during steady-state operation, this document does not set performance targets with respect to the amount or type of energy or resources to recover and/or use locally.

This document does not address transportation and any intermediary processes required to supply the treatment unit with the defined inputs. Provisions of this document apply to the treatment unit according to its unit boundaries, i.e. within the process chain beginning with its specified inputs and ending with its outputs. Some of the considerations on sustainability of the treatment unit are highlighted in Annex B.

2 Normative references

The following documents are referred to in the text in such a way that some or all of the 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.

ISO 4126 (all parts), *Safety devices for protection against excessive pressure*

ISO 5667-1, *Water quality — Sampling — Part 1: Guidance on the design of sampling programmes and sampling techniques*

ISO 5667-3, *Water quality — Sampling — Part 3: Preservation and handling of water samples*

ISO 5667-13, *Water quality — Sampling — Part 13: Guidance on sampling of sludges*

ISO 7250 (all parts), *Basic human body measurements for technological design*

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 14159, *Safety of machinery — Hygiene requirements for the design of machinery*

ISO/IEC 17065:2012, *Conformity assessment — Requirements for bodies certifying products, processes and services*

ISO 19458, *Water quality — Sampling for microbiological analysis*

ISO 20816-1, *Mechanical vibration — Measurement and evaluation of machine vibration — Part 1: General guidelines*

ISO 55000, *Asset management — Overview, principles and terminology*

ISO 80000 (all parts) and IEC 80000 (all parts), — *Quantities and units*

IEC 31010, *Risk management — Risk assessment techniques*

IEC 60050-192, *International Electrotechnical Vocabulary (IEV) — Part 192: Dependability*

IEC 60204 (all parts), *Safety of machinery*

IEC 60309-1, *Plugs, socket-outlets and couplers for industrial purposes — Part 1: General requirements*

IEC 60364 (all parts), *Low voltage electrical installations*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 60947 (all parts), *Low voltage switchgear and control gear*

IEC 61000-6, *Electromagnetic compatibility — Part 6: Generic standards*

IEC 61069, *Industrial process measurement, control and evaluation — Evaluation of system properties for the purpose of system assessment*

IEC 61140, *Protection against electric shock — Common aspects for installation and equipment*

IEC 61260-1, *Octave-band and fractional-octave-band filters — Part 1: Specifications*

IEC 61511 (all parts), *Functional safety — Safety instrumented systems for the process industry sector*

IEC 61558 (all parts), *Safety of transformers, reactors, power supply units and combinations thereof*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

IEC 61882, *Hazard and operability studies (HAZOP studies)*

IEC 61984, *Connectors — Safety requirements and tests*

IEC 62305 (all parts), *Protection against lightning*

IEC/IEEE 82079-1, *Preparation of information for use (instructions for use) of products — Part 1: Principles and general requirements*

EN 547 (all parts), *Safety of machinery — Human body measurements*

EN 1127-1, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 1837, *Safety of machinery — Integral lighting of machines*

EN 1839, *Determination of the explosion limits and the limiting oxygen concentration (LOC) for flammable gases and vapours*

EN 10216 (all parts), *Seamless steel tubes for pressure purposes — Technical delivery conditions*

EN 10217 (all parts), *Welded steel tubes for pressure purposes — Technical delivery conditions*

EN 13480 (all parts), *Metallic industrial piping*

EN 13725:2003, *Air quality — Determination of odour concentration by dynamic olfactometry*

EN 15259, *Air quality — Measurement of stationary source emissions — Requirements for measurement sections and sites and for the measurement objective, plan and report*

ASTM E681, *Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases)*

API 520, *Sizing, selection, and installation of pressure-relieving devices*

API 521, *Pressure-relieving and depressuring systems*

API 650, *Welded steel tanks for oil*

ASME B31.1, *Power piping*

ASME BPVC *Boiler and pressure vessel code*

SW-846 Test Method 1311, *Toxicity Characteristic Leaching Procedure*

Confidence Grading System, International Infrastructure Management Manual (IIMM), 2015

NFPA 30, *Flammable and Combustible Liquids Code*

UL 58, *Standard for steel underground tanks for flammable and combustible liquids*

UL 142, *Standard for steel aboveground tanks for flammable and combustible liquids*

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 http://www.electropedia.org/

3.1 General

3.1.1
human excreta
waste products of human metabolism, in solid or liquid form, generally urine and/or faeces

[SOURCE: ISO 24521:2016, 3.3]

3.1.2
faecal sludge
sludge generated from the storage of *human excreta* (3.1.1) in pit latrines, septic tanks or other onsite sanitation systems that may be mixed with flush water, domestic waste, anal cleansing material and other liquids

3.1.3
input
substances fed to the treatment unit; primarily *faecal sludge* (3.1.2), which may include other substances such as liquid and solid *domestic waste* (3.2.1) and may include different forms of *biomass* (3.2.2)

3.1.4
prefabricated
factory produced either as a fully assembled unit or as a set of components that assemble to form the unit

3.1.5
design requirement
requirement that specifies or constrains the design of a system or system component; *cf.* functional requirement, implementation requirement, interface requirement, performance requirement, and physical requirement

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.1146]

3.1.6
risk assessment
overall process comprising a risk analysis and a risk evaluation

[SOURCE: ISO/IEC Guide 51:2014, 3.11]

3.1.7
safety assessment
review of the aspects of design and operation of the treatment unit which are relevant to the protection of persons or the safety of the treatment unit, including the analysis of the safety and protection provisions established in the design and operation of the treatment unit and the analysis of risks associated with normal conditions and accident situations

3.1.8
design process
process of converting the requirements of the functional specification into the technical specification

[SOURCE: ISO 13880:1999, 3.3]

3.2 Input, energy balance, and resource recovery

3.2.1
domestic waste
waste that arises from domestic use of a private dwelling

3.2.2
biomass
material of biological origin excluding material embedded in geological formations and/or fossilized

Note 1 to entry: This definition includes crop waste, food waste, wood chips, etc. that can increase the calorific content of input beyond the content in faecal sludge.

[SOURCE: ISO 16620-1:2015, 3.1.2, modified — The Note has been added.]

3.2.3
steady state
condition in which all relevant operational parameters are not significantly changing with time

3.2.4
energy balance
accounting of *input* (3.1.3) and/or interconversion of different forms of energy outputs, and energy usage within a defined boundary

3.2.5
energy independent
able to perform the intended functions of the treatment unit relying exclusively on energy from *faecal sludge* (3.1.2) as defined by the manufacturer during steady state operation

3.2.6
energy positive
able to convert the treatment unit's defined *input* (3.1.3) into energy and/or output materials that can be converted into energy that can be reused in applications beyond the treatment unit

3.2.7
thermal treatment
treatment process that uses heat to convert *inputs* (3.1.3) into outputs

3.2.8
calorific value
quantity of heat produced by the combustion, at a constant pressure equal to 0,101 325 MPa, of unit volume or mass, the constituents of the combustible mixture being taken at reference conditions and the products of combustion being brought back to the same conditions

Note 1 to entry: A distinction is made between:

a) the superior calorific value (Hs)/ gross calorific value/ upper heating value (UHV) in which the water produced by combustion is assumed to be condensed, and

b) the inferior calorific value (Hi)/ net calorific value/ lower heating value (LHV) in which the water produced by combustion is assumed to be in the vapour state.

The units used for calorific value are either:

c) megajoules per cubic metre (MJ/m^3) on dry basis at the reference conditions, or

d) megajoules per kilogram (MJ/kg) on dry basis.

Note 2 to entry: This document does not mandate the use of the superior or inferior heating value as long as the one used is most relevant to the technology and clearly noted.

[SOURCE: ISO 22967:2010, 3.2.2, modified — The Note 2 to entry has been added, to remove “gas”, to include “/gross calorific value/upper heating value (UHV)” and “/net calorific value/lower heating value (LHV)”.]

3.2.9
biochemical oxygen demand
BOD
mass concentration of dissolved oxygen consumed under specified conditions by the aerobic biological oxidation of a chemical compound or organic matter

Note 1 to entry: It is typically expressed in mg/l.

[SOURCE: ISO 14592-2:2002, 3.1.3, modified — “in water” has been deleted, Note 1 to entry has been modified.]

3.2.10
chemical oxygen demand
COD
mass concentration of oxygen equivalent to the amount of a specified oxidant consumed by a chemical compound or organic matter

Note 1 to entry: It is typically expressed in mg/l.

[SOURCE: ISO 9408:1999, 2.6, modified — "when a water sample is treated with the oxidant under defined conditions" has been deleted, Note 1 to entry has been modified.]

3.2.11
total suspended solids
TSS
mass of particulates, both organic and inorganic, suspended, but not dissolved, per unit of water

[SOURCE: ISO 16345:2014, 2.58, modified — “weight” has been replaced with “mass’, Note 1 to entry has been deleted.]

3.2.12
total nitrogen
TN
sum of total Kjeldahl nitrogen (ammonia, organic and reduced nitrogen), nitrite-N and nitrate-N