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Household biogas system requirements: design, installation, operation, maintenance and safety

Exigences relatives aux systèmes de biogaz domestiques: conception, installation, utilisation, maintenance et sécurité

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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 Technical Committee ISO/TC 255, *Biogas*.

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

A household biogas system processes organic waste such as food scraps and manure into biogas which can be used for cooking, and into digestate that is convertible to natural fertilizer which can be used for gardening or soil improvement.

Biogas is a flammable gas, mainly composed of methane and carbon dioxide, generated by the anaerobic fermentation (without oxygen) of organic matter.

A household biogas system operates as a continuous-flow system, i.e. organic waste is fed in one end, and the gas and fertilizer are emitted from the other. The generated biogas is filtered to remove any unpleasant odours and toxic gases.

The digestate can be sanitized to reduce the amount of active pathogens in the effluent.

This document for Household Biogas Systems covers the small sized production and output of biogas for personal use in homes, kitchens, small farms, etc.

This document is applicable to all types and styles of household biogas systems, and it does not address any particular manufacturer of household biogas systems.

Household biogas system requirements: design, installation, operation, maintenance and safety

1 Scope

This document covers the requirements for the design, installation, operation, maintenance and the safety of Household Biogas Systems (HBSs), producing biogas in an amount equivalent to an installation capacity of less than 100 MWh per year.

The document applies to HBSs comprising of pipeline and equipment with pressure levels of less than 5 kPa.

Any equipment or appliances connected to an HBS or utilizing the biogas energy of an HBS are not a part of the scope of this document.

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.

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
anaerobic digestion
biological conversion of biodegradable materials by micro-organisms in the absence of oxygen creating two main products: *biogas* (3.2) and *digestate* (3.6)

[SOURCE: ISO 20675:2018, 3.1]

3.2
biogas
gas produced by anaerobic digestion of organic matter without further upgrading or purification

[SOURCE: ISO 20675:2018, 3.2, modified — 'gasification of biomass or power to gas from biomass sources' removed.]

3.3
biogas installation
installation including its pipelines, pipes and accessories for anaerobic digestion of *biomass* (3.5)

[SOURCE: ISO 20675:2018, 3.5, modified — 'gasification of biomass and waste, upgrading of biogas, liquefaction of biogas, storage of CO_2, storage of auxiliaries, storage of biomass and digestate' removed.]

3.4
biogas storage
buffer, gas holder, tank, vessel, bag or similar to store *biogas* (3.2)

[SOURCE: ISO 20675:2018, 3.7]

3.5
biomass
material of biological origin excluding material embedded in geological formations and/or transformed to fossilized material

[SOURCE: ISO 20675:2018, 3.9]

3.6
digestate
remaining effluent from the anaerobic digestion process including solid fraction and liquid fraction

[SOURCE: ISO 20675:2018, 3.19]

3.7
digester
anaerobic digestion installation including reactors, tanks and related equipment

[SOURCE: ISO 20675:2018, 3.20]

3.8
hydraulic retention time
theoretical average period of time a soluble compound remains in the *digester* (3.7)

Note 1 to entry: The hydraulic retention time (HRT) is calculated as net digester volume (m^3)/daily feedstock input (m^3/day).

[SOURCE: ISO 20675:2018, 3.28]

3.9
household biogas system
biogas installation which uses biomass from a single household for its own consumption and consists of a digester and an application for cooking, heating, lighting or electrical power

[SOURCE: ISO 20675:2018, B.3.1.1]

3.10
household biogas system owner
legal entity, a company or natural person owning the *biogas installation* (3.3)

[SOURCE: ISO 20675:2018, 3.31 modified — term changed from 'installation owner'.]

3.11
methane content
mol percentage of methane in *biogas* (3.2)

3.12
organic dry matter
part of *biomass* (3.5) or *digestate* (3.6) which consists of dry matter containing carbon and originating from living materials

[SOURCE: ISO 20675:2018, 3.44]

3.13
organic loading rate digester
amount of volatile *organic dry matter* (3.12) entering the anaerobic *digester* (3.7) over time, measured in kilograms per m^3 net digester volume and day

Note 1 to entry: The organic load gives an indication on biological degradation of the *substrates* (3.18). It provides information on nutrient supply levels of the microorganisms involved, overload or undersupply of the system as well as resulting technical and process control measures to be taken. The organic load describes the efficiency of the anaerobic digester.

[SOURCE: ISO 20675:2018, 3.45]

3.14
raw biogas
biogas (3.2) directly from the *digester* (3.7) which is not conditioned, so it is not dried and cleaned

[SOURCE: ISO 20675:2018, 3.48]

3.15
solid retention time (SRT)
period of time expressed in days the *biomass* (3.2) is in the *digester* (3.7) for anaerobic digestion

Note 1 to entry: The solid retention time (SRT) is calculated as the net capacity for biomass content in the digester (kg)/daily feedstock input (kg/day).

[SOURCE: ISO 20675:2018, 3.53]

3.16
specific biogas production
standard state volumetric *biogas* (3.2) production expressed in normal cubic meters per liquid volume in cubic meters of the digester per day

[SOURCE: ISO 20675:2018, 3.54]

3.17
specific biogas yield
standard state volumetric biogas production expressed in normal cubic meters per kilogram *organic dry matter* (3.12) of the feedstock

[SOURCE: ISO 20675:2018, 3.55]

3.18
substrate
part of the *biomass* (3.5) which is biodegradable and converted by micro-organisms and/or enzymes as catalyst into *biogas* (3.2)

[SOURCE: ISO 20675:2018, 3.56]

3.19
supplier of the household biogas system
legal entity or a company which designs, manufactures or constructs and delivers the *biogas installation* (3.3) to the *household biogas system owner* (3.10)

[SOURCE: ISO 20675:2018, 3.57]

4 Symbols and Abbreviated Terms

HRT Hydraulic Retention Time

MWh Megawatt Hour

SRT Solid Retention Time

HBS Household Biogas System

5 Household Biogas System (HBS) Design and Construction

5.1 HBS general design

The HBS shall include the following devices:

— biomass inlet

— digester

— biogas storage

— biogas outlet

— biogas transfer system

— digestate outlet

— H_2S filter

— disinfection unit (optional, depending on local regulations)

— an excess biogas release valve which shall automatically open at pressures greater than 20% of the regular working pressure of the system.

— a manual biogas shutoff valve parallel to the automatic excess biogas release valve, from the biogas storage

NOTE 1 see Annex A Schematic of Household Biogas System.

The HBS shall be designed in a manner not to allow deformation due to environmental conditions, greater than 2 %.

The HBS shall be designed in a manner to exclude the entrance of air under all operating conditions.

The HBS shall not have any leakage during the hydrostatic pressure head test at 150 % of the regular system working pressure.

Where electrical service is required, the installation and all electrical wire, fixtures and equipment shall meet international and local standards.

Monitoring and alarm systems are allowed.

NOTE 2 Monitoring and alarm systems can enhance safety, especially in cases when using the HBS for indoor applications, but in most cases not feasible due to economic and technical reasons.

Chimneys are allowed to remove excess gas.

5.2 Materials

The materials used in the construction of a HBS shall:

— be compatible for a biogas environment

— have tensile strength not less than 12 N/mm^2.

— have a gas permeability of less than 350cc/m^2/d/bar of methane

— not be hazardous to the user

The materials used in the construction of the digester and the biogas storage chamber shall be such that not impart any colour, odour or any toxic effect and do not contaminate the biomass slurry.

The materials used for the biogas outlet pipe shall be compatible for use in biogas systems, i.e, non-corrosive and of low permeability.

5.3 Digester

5.3.1 General

The digester should preferably be installed outside or at least in a well-ventilated place with a refreshing rate of at least 5 times per hour the content of the rooms.

The digester cover shall be designed to withstand all external and internal loads and shall be able to collect and convey the biogas to the gas outlet.

The biogas digester internal and external surfaces and the biogas storage shall be free of hidden internal defects such as air bubbles, pits and metallic or other foreign materials.

All pipes and components within the digester shall be securely anchored to prevent displacement due to normal forces including loads from accumulated scum.

The biogas collection system within the digester shall be designed as to facilitate the exclusion of floating debris.

The biogas collection, transfer and control system shall be designed to safely convey the biogas produced within the digester to the biogas utilization equipment.

Instrumentation including means of measuring pressure and temperature, filters for chlorine and biogas are allowed.

NOTE 1 When temperatures are below mesophilic range, biogas production will be drastically reduced.

5.3.2 Digester size

The digester shall be of sufficient size to retain the total volume of the organic waste and water, according to the digester designed retention time.

The size of the digester (V_d) shall be determined on the basis of the chosen solid retention time (SRT) and the daily substrate input quantity (S_d).

The retention time shall be sufficiently long to ensure that the amount of microorganisms removed with the digestate is not greater than the amount of the reproduced microorganisms.

Digester retention time shall not be less than 20 days.

The calculation of digester size is:

$$V_d = (S_d \text{ x SRT}) \text{ x } (1 + O_v/100)$$