INTERNATIONAL STANDARD

ISO 23590

First edition
2020-12

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

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

Reference number
ISO 23590:2020(E)

COPYRIGHT PROTECTED DOCUMENT

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

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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 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:

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

where

V_d is in cubic meters or liters

S_d is in cubic meters/day or liters/day

SRT is in days

O_v is overhead volume in percent

5.4 Pipes, Fittings and Connections

All pipes and fittings shall be of adequate size to facilitate the process flow within the biogas installation.

Inlet and outlet pipes shall be connected in a manner that facilitates process flow and allow cleanout.

The pipes shall be constructed as to allow the safe isolation of all sections of the system, as part of the routine cleaning and maintenance schedule.

The biogas transfer pipe:

— should be protected from any damage;

— may be installed above ground;

— is allowed to be buried, depending on local construction requirements;

— shall include provision for drainage of water condensate.

Biogas pipes installed within buildings shall be adequate to withstand pressures greater than 15 kPa and shall not be buried.

The location of interior piping is subject to local construction requirements and possibilities (such as ventilation, foundations, detections, etc.)

Outlet connections shall be an integral part of the digester system and shall be compatible with pipes and joints finished in a manner as not to allow a leakage of biogas slurry during the life span of the HBS.

The biogas outlet connection shall be designed as not to allow any gas leakage at the base of the joint of the biogas storage.

The biogas outlet valve shall be designed in a manner as not to allow any gas leakage.

The supplier of a HBS shall list the specifications of the materials used within the system.

6 Components Testing and Sampling Criteria

All of the individual parts of a HBS of the same raw material, same type, same size and produced under relatively uniform conditions of manufacturing shall constitute a “lot”.

Sampling of parts of a HBS shall be selected randomly from the lot.

Sample size shall be in accordance with the following table and shall be tested according to the appropriate test.

Lot Size	Sample Size	Acceptance Number
Up to 50	1	0 Failure
51 – 200	2	0 Failure

201 – 300	3	0 Failure
301 – 500	5	0 Failure
501 and above	8	1 Failure

7 System Manuals

The owner of a HBS shall be provided with Installation, Operation and Maintenance Manuals within a printed version.

The manuals shall include installation instructions, operating instructions, maintenance instructions, cleaning procedures, safety precautions, trouble-shooting instructions, disposal procedures, safety procedures and proper caution and warning signs, information on the pipes and fittings and the correct installation requirements.

The manuals shall include the name, address, telephone number and email address of the supplier of the HBS.

The manuals of the HBS shall clearly and explicitly explain the requirements for safely installing and operating the system and for minimizing any and all hazardous conditions.

The Installation and Operation manuals shall clearly and explicitly state that all equipment, such as stoves and lighting, must be compatible with or adapted for biogas energy usage.

The supplier of the HBS shall be available to the HBS owner to receive inquiries concerning installation, operation and maintenance of the system.

The supplier of the HBS shall provide a training program in the proper operation and maintenance of the household system.

The training program may be conveyed either onsite or through manuals, videos and internet.

8 Prerequisites for Installation

The following requirements shall be satisfied before installing a HBS:

a. Sufficient space shall be available for the HBS;

b. The space should preferably be near the source of the biomass;

c. The space should be close to the place where the biogas will be used;

d. The space should be secure from hazards;

e. The ground should be firm and compact enough to support the weight of the system in order to avoid any physical movement or breakage of the system.

9 Household Biogas System Operation

The biogas produced shall be free of particulate matter such as dust and dirt.

The biogas shall be produced by anaerobic digestion of the biomass.

The biomass shall contain substrates for anaerobic digestion such as manure, sludge, household waste, agricultural waste, and food residues.

Water can be used to dilute the organic load as per instructions and recommendations of the supplier of the HBS.

Unwanted materials such as straw, stones and dirt shall be filtered and removed before the mixing process with water.

The biogas produced generally has the following composition:

Methane	{CH_4}	40 %- 75 %
Carbon Dioxide	{CO_2}	14 %- 45 %
Nitrogen	{N_2}	0 %-5 %
Hydrogen	{H_2}	0 %-1 %
Hydrogen Sulphide	{H_2S}	1-10,000 ppm (before filtration)
Water Vapor	{H_2O}	2 %-7 %
Oxygen	{O_2}	0 %-1 %

A biogas outlet filter shall be installed to reduce the composition of the hydrogen sulphide to a level of at least a minimum of 0.5 ppm and a maximum of 100 ppm.

NOTE 1 In the event that the HBS connected appliance is used inside a room and the biogas flow is released with no burning (left open or leaking), biogas will release to the air after it passed the safety valve and the H_2S filter (biogas outlet filter reducing the H_2S content to up to 100 ppm). In a ventilated (naturally or mechanically) room, the H_2S content will be diluted to a concentration well below 100 ppm (about 100 ppm H_2S turns off the sense of smell).

For table illustrating the effect of different H_2S concentrations on humans please refer to Annex B.

The digestate may be used as an organic fertilizer as per the instructions and recommendations of the supplier of the HBS.

Periodically, as per the instructions and recommendations of the supplier of the HBS, the biomass sediment ("sludge") may be released from the base of the digester.

The biomass sediment may be used as an organic fertilizer as per the instructions and recommendations of the supplier of the HBS.

10 Maintenance and Troubleshooting

The supplier of the HBS will prepare a schedule for periodic inspection and maintenance of the system.

Unless otherwise stated in the maintenance manual, the HBS owner will inspect at least once a year the gas filters, the valves, the pipes, the fittings-and will check at least once a year for gas and liquid leakage. The inspection will include putting soapy water on all pipe connections and to observe for any accumulating bubbles.

Unless otherwise explicitly stated in the maintenance manual, the HBS owner will change the gas filter at least once a year.

Unless otherwise explicitly stated in the maintenance manual, the HBS owner will inspect the disinfection unit on the digestate outlet at least once a month. When needed the HBS owner will add disinfection agent as instructed in the maintenance manual.

Depending on the composition and the local requirements supplementary disinfection equipment may be required on the digestate outlet.

Warning — When using chlorine, the vapours shall not be inhaled as tri-halo methane can be formed which is highly carcinogenic. It is recommended to store the fertilizer in a vented or

open space and to wait 24 hours before using it. That will allow the chlorine to evaporate before using the fertilizer.

Effluent produced using human waste should be diverted directly to a treatment solution without potential for human contact, such as city sewage system, septic tank, drain field or mulch basin (to be checked according to local regulations).

The supplier of the HBS will provide instructions in the maintenance manual how to repair the digester and the biogas storage.

The supplier of the HBS will prepare a troubleshooting checklist of potential operational problems and symptoms. For each item listed, the HBS owner will be given instructions how to evaluate and resolve the problem.

As part of the troubleshooting instructions, the HBS supplier will provide directions on the proper pH level within the digester.

The ideal environmental temperature for operating a HBS is above 20° Centigrade. Below this temperature the HBS will operate less efficiently. Each HBS supplier will advise how to operate at lower temperatures or provide guidance on how to maintain temperatures.

11 Markings

All HBS systems installed shall be clearly and distinctly "marked" with the following information:

a) Manufacturer's name, address, telephone number and email address;

b) Manufacturer's trade mark;

c) Serial Number

d) Country of origin;

e) Manufacture date;

The marking shall be carried out either by painting, by moulding or by sticking the identification marking on the external surface of the biogas installation system.

The markings shall be permanent.

The HBS shall be marked in a visible location with signs which describe unallowable activities and distances as specified in the risk assessment and risk analysis evaluation.

12 Safety

The supplier of a HBS shall do a risk assessment and risk analysis of the whole system in order to identify hazards, quantify risks and to determine components, safety measures and/or human interventions important for safe operation of the system.

The following safety items will be explicitly stated and marked on the HBS:

— Do not light a fire or create sparks within a distance of 5 meters (15 feet) from the system.

— Do not drink the liquid effluent.

— Smoking is prohibited within at least 3 meters (10 feet) around the system.

In case of using an indoor biogas appliance, the area of use must be properly ventilated.

13 Warranty and Guarantee

The Installation, Operation and Maintenance manuals shall include warranty and guarantee clauses.

The owner of the HBS shall be provided with a certification of product liability.

The warranty period on parts and materials shall not be less than two years.

The life span of a HBS shall not be less than five years.