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Biogas systems — Non-household and non-gasification

Installations de méthanisation — Non domestique et sans gazéification

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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

0.1 General

The technical committee on biogas (ISO/TC 255) was established in 2011 in order to:

— provide liberalization and facilitation for international trade of biogas systems;

— contribute to international co-operation on technical regulations, standards and assessment procedures;

— curb discriminatory technical requirements as the main form of trade protectionism; and

— reduce and eliminate the technical barriers for international trade of biogas systems.

This document about biogas systems is applicable for biogas production by anaerobic digestion, biogas conditioning, biogas upgrading and biogas utilization. The main purpose of this document is the safe operation of biogas systems without damaging the environment.

The availability of a standard for biogas systems is necessary in order to:

— ensure that biogas systems are built, operated and maintained safely;

— facilitate development of regional and national regulations and incentive programs to regulate methane emissions;

— moderate communication between the different biogas parties through meaningful discussions;

— contribute to reinforcement of biogas flares' safety and business competitiveness with recognized terms and definitions that clarify actors' expectations related to procurement, contracts and services as well as reporting on biogas related action plans, road maps, etc.; and

— contribute to the use of standards by facilitating their development and furthering users' understanding and application of standards.

ISO/TC 255 intends to promote international technology exchange and to accelerate international application of biogas (products) and equipment by developing and maintaining globally harmonized standards. For the avoidance of doubt, it is noted that national legislation may apply which may deviate from or may be additional to the contents of this document.

0.2 Description of the applied technologies

Biogas systems are amongst others applied at industrial plants like food and beverage industries, waste water treatment plants, waste plants, landfill sites, and small-scale plants next to agricultural companies.

Biogas is produced by anaerobic digestion of organic matter.

Biogas mainly comprises methane, carbon dioxide, nitrogen, oxygen, hydrogen sulphide and/or water and furthermore could contain hydrogen, carbon monoxide, heavier hydrocarbons (including aromatic hydrocarbons), siloxanes and/or other substances.

Biogas can be treated in order to eliminate hydrogen sulphide, siloxanes, water and other substances and be upgraded to a gas with higher methane content. Sometimes the biogas is pressurized.

A description of the most common technologies used in biogas systems is included in Annex B.

Guidelines to prevent risks from gasses and explosive atmospheres in buildings are included in Annex C.

Biogas systems — Non-household and non-gasification

1 Scope

This document applies for systems for biogas production by anaerobic digestion, biogas conditioning, biogas upgrading and biogas utilization from a safety, environmental, performance and functionality perspective, during the design, manufacturing, installation, construction, testing, commissioning, acceptance, operation, regular inspection and maintenance phases.

The following topics are excluded from this document:

— boilers, burners, furnaces and lighting in case these are not specifically applied for locally produced biogas;

— gas fuelled engines for vehicles and ships;

— the public gas grid;

— specifications to determine biomethane quality;

— transportation of compressed or liquefied biogas;

— transportation of biomass or digestate;

— assessment and determination whether biomass is sourced sustainably or not.

An informative explanation of the scope is included in Annex A.

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.

ISO 20675, *Biogas — Biogas production, conditioning, upgrading and utilization — Terms, definitions and classification scheme*

ISO 22580, *Flares for combustion of biogas*

IEC 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres*

IEC 62305-2, *Protection against lightning — Part 2: Risk management*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20675 and the following 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
hazardous substance
any product or chemical that has properties which are explosive, flammable, oxidising, toxic, corrosive or toxic to the environment

4 Abbreviated terms

CBG compressed biogas

CBM compressed biomethane

CNG compressed natural gas

HAZID hazards identification study

HAZOP hazards and operability study

LBG liquefied bio gas

LBM liquefied biomethane

LNG liquefied natural gas

SDS safety data sheet

P & ID piping and instrumentation diagram

PPE personal protective equipment

PSA pressure swing adsorption

PVC polyvinyl chloride

RIE risk evaluation and inventory

THT tetrahydrothiophene

TRA task risk analysis

CHP combined heat and power plant

5 Guide for reading this document

This document consists of different types of systems that might or might not be used in combination with each other. Clauses 1 to 9, and Clauses 12 to 13 are applicable for all types of system. Table 1 shows which chapters are applicable to the type of system.

Table 1 — Clauses applicable to the type of system

Type of system	General clauses	Specific clauses in force
Biogas production	Clauses 1 to 9 and Clauses 12 to 13	Clause 10
Systems of biogas treatment, CHP, biogas upgrading and liquefaction	Clauses 1 to 9 and Clauses 12 to 13	Clause 12

6 Safety principles

In the conceptual, basic and detailed design and management of biogas systems, the following principles shall be used to deal with risk based on declining preference:

— Eliminate: Minimize the risk of exposure and the influence of the human actor. Consider process design and process control measures.

— Manage: Risk management; In design, think about maintenance and inspection of equipment and controls, and how risks can be mitigated. This may include the generation of alarms for human handling, physical security systems (such as pressure protection and flame arresters), and instrumental safety systems.

— Accept: Acceptance of risks shall be avoided at all times. If technical elimination or control is not possible or if these measures fail, procedural measures shall be taken to control the risks. Emergency plans are an example of this.

Since in many cases biogas systems are small-scale and in some cases the people concerned have limited knowledge of the risks of industrial plants such as gases, high temperatures and pressures etc., special attention is paid to knowledge, culture and behaviour. This can include recurrent training and training of relevant employees and third parties.

The following elements play a role in safety:

— process safety;

— explosion and fire safety;

— safe management of the biogas system.

As basis for this document, the following safety measures have been taken into account:

— technical safety measures have priority above organizational measures;

— maintenance systems or parts of systems shall have provisions for isolation and be able to be locked out and tagged out for maintenance;

— the system can be controlled;

— the system can be maintained, for this reason sections of the process can be isolated;

— pressures safety control system is working properly;

— in case of electrical power interruption, the system shall automatically go to safe mode ('fail safe');

— monitoring of gases unintentionally released;

— sufficient mechanical and natural ventilation:

  — lightning study, particularly in the event of zones with explosion risks;

— alarm alerts and transfer of these alarms to the responsible people;

— for compiled systems (for example, parts of the system from different vendors), safe installation and maintenance of the total system shall be integrated.

7 Safety studies

7.1 General

In many cases, a risk study or an additional risk inventory and evaluation is required for biogas systems. Also, specific national regulations can be applicable for large biogas systems with significant risks for the surroundings.

Companies shall investigate themselves whether specific safety regulations are applicable. This can depend on the biogas composition and the system size.

7.2 Risk assessment and evaluation

7.2.1 Risk assessment construction, start-up and maintenance

During design and prior to the start of the construction, risk assessment and evaluation (regarding occupational health aspects) shall be performed. Generally, this is mandatory because of national health and safety regulations. For specific risks additional task risk analysis shall be made by the involved workers and construction managers before the start of the activities.

Before the start of the commissioning and the operation, an additional risk assessment and evaluation shall be done. Specifically, the start-up and shut-down of a biogas systems can cause specific safety risks. A list of preventive measures shall be part of the report. All the intervention and maintenance procedures shall be established before the commissioning of the plant. The same applies to the start-up, shutdown, and maintenance of all equipment.

These risk assessments are additional to the HAZOP mentioned below.

7.2.2 HAZOP/HAZID

Process safety risk assessment tools which are often used are HAZID and HAZOP and are described in this subclause.

The implementation of a hazards and operability study (HAZOP), a hazards identification study (HAZID), or similar risk assessment tools are recommended in this document prior to commissioning and prior to the implementation of changes. Please refer to national regulations to see if this requirement is mandatory. If standard systems are realized, this shall be done for the standard part only once and not for each location specifically. In such case, an assessment of location-specific and project-specific risks related to environmental factors that can increase risk shall be added. In case the biogas system consists of several subsystems, a HAZOP shall be executed for the entire system including the interfaces between the subsystems.

Although a HAZOP is required prior to the commissioning, it is advisable to carry this out in the conceptual stage of the design and, if necessary, to be repeated in the further stages of design. It is important to take explosion protection and process safety into account in the design.

A HAZOP shall be performed by multidisciplinary specialists for design, operations and maintenance with knowledge of the gas-side part of the system and the risks. The chairman and preferably a part of the specialists shall be independent from the supplier.

At least three multidisciplinary specialists shall participate in the HAZOP. The following expertise is required during a HAZOP:

— independent chairman;

— safety expert (can also be independent chairman);

— process engineer;

— process control engineer;

— mechanical engineer;

— (civil/structural engineer).

The following documentation is required for a HAZOP session:

— action list;

— P & ID;

— lay-out drawing;

— operating and maintenance instructions (see Clause 13).

For more details regarding the executing of HAZOP, refer to IEC 61882.

7.3 Explosion protection document (EPD)

It is recommended that the owner of the system prepares an explosion protection document (EPD) prior to the start of work or prior to changes in the workplace, work tools or work process.

NOTE In the EU, this is mandatory according to ATEX 1999/92/CE. In North America, area classifications are defined by NFPA 820. Other risk evaluations or equivalent reports can be integrated therein.

The EPD shall contain at least the following information:

— identification of the risks and the considerations made herein;

— adequate measures which have been taken for safe operations and maintenance;

— which locations are classified as an explosion safety zone including safety requirements;

  — lightning study determining the risks of lightning in relation to explosion safety zones and measures;

— documentation proving that the workplace and work equipment, including warning devices, are designed with due regard for safety, operation and maintenance; and

— documentation regarding the safe use of work equipment.

7.4 Environmental requirements

Besides safety in the design of biogas systems, it is very important to observe the environmental requirements during the design and before the start of procurement and construction. This prevents adjustments in a later stage after commitments have been made.

The environmental requirements are addressed in national or regional legislation. Most important items to take into consideration are soil protection, surface water protection, noise, odour and storage of hazardous materials. Specifically, for soil protection, it is important to use liquid-tight floors in buildings, to prevent soil pollution by for example mineral oils. It shall be noted that soil protection as well as overflows or leakages of biomass or digestate storage might lead to surface water pollution.

In the context of environmental pollution, it is also important to minimize the loss of methane (greenhouse gas) of biogas systems making use of best practices such as leak testing. The potential sources of methane loss shall be identified and, if a loss of methane occurs, measures shall be taken immediately shall reduce it as much as reasonably practical.

NOTE This document does not include a maximum percentage of methane loss for the biogas system, because limit values are arbitrary. Common areas where methane losses occur are: biomass/digestate storage, pressure relief valves, CHP, flare, biogas treatment and upgrading systems.

8 General design requirements

8.1 Materials and structures

8.1.1 General

This subclause describes general design requirements for materials and structures.

8.1.2 Materials

Requirements for materials and structures are applicable to:

— roofs;

— load-bearing structures;

— pipes and pipelines (above ground and underground);

— process equipment, vessels, storage tanks;

— floors (whether or not liquid-tight), stairs, platforms; and

— walls.

It shall be noted that the materials used are suitable for:

— contact with substances in biomass, biogas or chemicals;

— corrosion;

— pressure: for pressure-containing vessels and pipes (> 50 kPa), the choice of material shall also comply with national regulations (such as PED in the EU);

— weights (including pressure load), also depending on the shape and dimensions of the structure;

  — the expected temperature and temperature changes;

— climate conditions (such as wind, sun, snow, earthquakes).

For piping, plastic or steel materials can be applied. PVC shall not be used as material for biogas due to poor experience with durability. A technical study shall show which material shall be used depending on the gas or fluid transported and the atmosphere in which the pipes are located. In case polyethylene (PE) or other plastic materials are used for piping the materials shall be resistant against extension by heat and against UV-radiation, especially for above ground piping. In case steel is used for piping, rustproof galvanized steel or rustproof stainless steel can be used. In case rustproof stainless steel is used, at least AISI 304 shall be applied in case the H2S concentration is lower than 900 mg/m^3, and AISI 316 in case the H2S concentration is 900 mg/m^3 or more. Supporting structures shall be made of rustproof hot dip galvanized steel or stainless steel. For cast products such as valves and flame arresters, low copper aluminium can be applied. For underground pipelines, refer to 9.2.

In case of use of different steel materials (e.g. stainless steel and galvanized steel), these materials shall be separated from each other to prevent galvanic corrosion.

In the operations manual, it shall be recorded which materials are chosen and for what reason.

The technical life time of structures, tanks, reactors, vessels and pipes of the system shall be specified by the supplier and be described in the operations or maintenance manual.

8.1.3 Structures, weight and stability calculations

Requirements for structures are applicable to:

— roofs;

— load-bearing structures;

— pipe supporting;

— storage tanks, supports for vessels;

— floors, stairs, platforms; and

— walls.

Generally national regulations contain detailed requirements for structures, roofs, floors, walls, stairs and platforms and for the weight and stability calculations. Climate conditions as wind, sun, snow and earthquakes shall be considered.

In order to use and access the plant safely, facilities such as stairs and platforms shall be present. Based on a risk assessment and depending on the height, frequency of use and way of use a proper design for the stairs and platform shall be made.

8.1.4 Use of used materials and equipment

The use of used materials is allowed provided these materials are in accordance with the requirements of this document.

8.2 Process system facilities

8.2.1 General

This subclause describes the requirements for equipment, pipes, valves and other process system facilities with regard to:

— the gas-side part of the system (parts containing gas or in in direct contact with gas); and

— cooling systems using refrigerants.

8.2.2 Gas-side part of the system

Requirements for equipment, pipes, valves and other process system facilities of the gas-side part of the system are:

— Pipes on the pressure side of pumps and compressors shall be provided with a back-flow preventer or non-return device;

— Pipes on the suction side of pumps and compressors are provided with a manual or automated shut-off valve as close as possible to this equipment or, if applicable, connected vessel;

— Spigot-and-socket joints that are not in themselves axially restrained shall be secured against thrust according to the pressures arising. The pipe connections shall be axially restrained;

— Pumps, compressors and agitators used for hazardous substances shall use a mechanical seal, or a similar shaft seal to prevent leaks;

— Gas valves shall be able to be closed manually. Shut-off valves, which shall continue to function in case of fire, shall be carried out fire-resistant;