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Biogas systems — Non-household and non-gasification

Systèmes du biogas — Non-ménage et non-gazéification

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Foreword

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This document was prepared by Technical Committee ISO/TC 255 Biogas, Working Group 5.

Introduction

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 International Standard 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.

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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 will be pressurized.

A description of the most common technologies used in biogas systems is referred to Appendix B.

Biogas systems — Non-household and non-gasification

1 Scope

This International Standard 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 International Standard:

— 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.

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 4427, *Plastics piping systems for water supply, and for drainage and sewerage under pressure*

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

ISO 22580, *Flares for combustion of biogas*

IEC 60079, *Explosive atmospheres*

IEC 60204, *Safety of machinery - Electrical equipment of machines*

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

IEC 61882, *Hazard and operability studies (HAZOP studies) - Application guide*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20675 “Terms, definitions and classification scheme for the biogas production, conditioning, upgrading and utilization” apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

4 Abbreviations

— CBG 'Compressed bio gas'

— CBM ‘Compressed Bio Methane’

— 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 & Instrumentation Diagram

— PPE Personal Protective Equipment

— PSA Pressure Swing Adsorption

— RIE Risk Evaluation and Inventory

— THT Tetrahydrothiophene

— TRA Task risk analysis

— CHP Combined heat and power plant

5 Guide for reading this standard

This standard consists of different types of systems that may or may not be used in combination with each other. The first part of this document is applicable for all types of system. Table 1 shows which chapters are applicable to the type of system.

Table 1 — Chapters applicable to the type of system

Type of system	General Chapters	Specific chapters in force
Biogas production	1 to 9, 14 ,15	10
Systems of biogas treatment, CHP, biogas upgrading and liquefaction	1 to 9, 14 ,15	12

6 Safety principles

The content of this chapter is based on the working draft of the technical report ISO 23585.

In the design and management of biogas systems, the following principles has to 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 must be avoided at all times. If technical elimination or control is not possible or if these measures fail, procedural measures must 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 persons 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 may 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 standard, the following safety measures have been taken into account:

- Technical safety measures have priority above organizational measures
- Maintenance systems or parts of systems must be able to be separated ("blocked in") and to be locked out and tagged out for maintenance
- The system can be controlled
- The system can be maintained
- Pressures safety control system is working properly
- In case of electrical power interruption, the system will automatically go to safe mode ('fail safe')
- Monitoring of gases unintentionally released
- Sufficient mechanical and natural ventilation
- Alarm alerts and transfer of these alarms to the responsible persons
- For compiled systems (for example, parts of the system from different vendors), safe installation and maintenance of the total system have to be integrated

7 Safety studies

7.1 Introduction

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 must 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 technical aspects) has to be executed. Generally this is mandatory because of national health and safety regulations. For specific risks additional task risk analysis should 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 should be done. Specifically the start-up of a biogas systems can cause specific safety risks. A list of preventive measures has to be part of the report. All the intervention and maintenance procedures must 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 Process safety risk assessment tools which are often used are HAZID and HAZOP and are described in the next paragraph. (HAZOP/ HAZID)

The implementation of a Hazards and Operability Study (HAZOP), a Hazards Identification Study (HAZID), or similar risk assessment tools are recommended in this standard 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 should 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 may increase risk has to be added. In case the biogas system is delivered or built by multiple vendors, a HAZOP needs to be executed for the whole system including the interfaces between the subsystems.

Although a HAZOP is required prior to the commissioning, it is advisable to carry out this is already 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 should 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 should be independent from the supplier.

The following attendees are 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 (Chapter 13 'operating instructions)

For more details regarding the executing of HAZOP is referred to IEC 61882:2016 Hazard and operability studies (HAZOP studies) - Application guide.

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 must 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;
- 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 take liquid-tight floors in buildings, to prevent soil pollution by for example mineral oils. It has to 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. The potential sources of methane loss have to be identified and in case of methane loss this has to be reduced as much as possible immediately.

NOTE This standard 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 paragraph 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);
- vessels, storage tanks;

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

It has to 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 (> 0.5 bar), the choice of material must 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;
- climate conditions (such as wind, sun, snow, earthquakes).

Piping materials have to be made of stainless steel. At least AISI 304 in case the H2S concentration is lower than 600 ppm and stainless steel AISI 316 in case the H2S concentration is 600 ppm or more. Supporting structures should be made hot dip galvanized steel or stainless steel.

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

In the operations manual it has to 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 have to be considered.

8.1.4 Use of used materials and equipment

The use of used materials is allowed in case these materials comply with the requirements in this standard.

8.2 Process system facilities

8.2.1 Introduction

This chapter 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 have to be provided with a 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 must be secured against thrust according to the pressures arising. The pipe connections must be axially restrained;
- Pumps, compressors and agitators used for hazardous substances must utilize a single mechanical seal, or a similar shaft seal to prevent leakage;
- Gas valves must be able to be closed manually. Shut-off valves, which need to continue to function in case of fire, have to be carried out fire-resistant;
- Valves have to be tested for tightness annually;
- In the absence of power supply, the automated shut-off valves must take the safe position ("fail safe"). Valves which are necessary in emergencies, have to be operated manually or self-closing in case the automation fails;

It is advisable to place a manual valve before the biogas pipe or pipeline enters the biogas system, at an accessible location (preferably just outside or inside the gate of the plant). This valve may not be accessible to unauthorized persons.

- Looking at a shut-off valve it has to be easily accessible and visible that it is opened or closed;
- Vessels, reactors and filter systems have to be equipped with a pressure relief valve (see the next paragraph (8.3) regarding pressure protection). The outlet of the pipes of the pressure system (vent) must be routed to a safe location (controlled and zoned location);
- Condensate drain facilities must be constructed in a way that discharge of condensed water does not reach the soil, but for example, is returned to the digester. Condensate drain facilities must be easy to inspect and maintain without having to climb into shafts or pits. Pressurised seal systems must be designed such that the sealing liquid is unable to escape when the system is triggered but instead flows back automatically. The filling level of the liquid seal corresponds at least to a pressure of 15 hPa (150 mm water column or 15 mbar) above the maximum response pressure of safety devices and is monitored using measuring instrumentation; and
- Process control and pressure safety systems in a way that safe process operation is guaranteed and intervention takes place in case of deviations. During failing of these systems, safe process operation must be guaranteed.

8.2.3 Cooling systems

For cooling systems using refrigerants (especially refrigerants which are damaging the ozone layer) is referred to national regulations about design, regular testing, certificates, log books etc.. It is critical no leakage occurs, because the refrigerants are ozone layer threatening.

8.3 Pressure protection

A system for biogas treatment, combined heat and power generation, biogas upgrading, liquefaction, including vessels, reactors, tanks, pipes and pipelines, have to be gas-tight and has to be provided with a pressure relief valve.