issa | INTERNATIONAL SOCIAL SECURITY ASSOCIATION
Section on Prevention in the Chemical Industry
Section on Machine and System Safety

VISION ZERO
Safety.Health.Wellbeing.

Factsheet on Explosion Protection

Biogas plants – Safe handling of biogas

002

Introduction

Biogas plants are comprised of different equipment such as machines, containers, tanks, pipes and measuring devices for the production, cleaning, conveying, measuring, storing, and utilisation or flaring of biogas.

Biogas is a combustible gas mixture obtained by fermentation of organic substances under exclusion of air. The composition depends on the starting materials and the reaction process. Dry biogas mainly consists of:

- Methane (50 to 75 % by volume)
- Carbon dioxide (20 to 50 % by volume)

Hydrogen sulfide, nitrogen, oxygen, ammonia and hydrogen may be present in small amounts as well.

This factsheet illustrates the fundamental protection measures for the production, conveying, storing and utilisation of biogas based on factsheets and guidelines of European countries.

National regulations, however, must be adhered to. It is possible that recommendations in this factsheet deviate from national requirements. In the chapter „Further literature", selected national regulations are listed.

Hazard

The main hazard when handling biogas are the combustibility of methane and the explosiveness of methane/air mixtures.

The explosion range of methane lies between 4 % and 17 % by volume in air.

Further hazardous components of biogas are the asphyxiant carbon dioxide and the toxic hydrogen sulfide, which can be lethal even at low concentrations. The density of biogas is influenced by its carbon dioxide content, the atmospheric pressure and temperature. The higher the concentration of carbon dioxide, the higher the density of biogas. If the composition of biogas is unknown, it has to be assumed that biogas can accumulate at the ceiling as well as in basements, pits, shafts and other cavities.

Explosion prevention

In places where biogas plants or parts thereof are installed one must consider the hazard of an explosion. These areas should be classified into Ex-Zones 0, 1 or 2 in accordance with national guidelines.

In places where explosive atmospheres may occur, ignition sources must be avoided, or other protective measures have to be taken to eliminate the risk of ignition. Effective ignition sources include flames, hot surfaces, electrical sparks, static electricity, mechanically created sparks and lightning strikes.

In explosion zones the following equipment categories must be used respectively:

- in zone 0: equipment category 1G
- in zone 1: at least equipment category 2G
- in zone 2: at least equipment category 3G

All conductive parts must be bonded and earthed.

Floor drains in Ex-Zones have to be designed and built to avoid spreading of escaping biogas to other areas.

Places where explosive atmospheres may occur need to be marked with the warning sign „EX".

An explosion protection document is required. It must include at least zoning of the whole biogas plant and a description of the technical protection measures implemented (prevention of explosive atmosphere, avoidance of ignition sources, constructive explosion protection measures) and the organisational measures that have been taken.

Ventilation measures

Installation rooms (e. g. pump rooms) must be sufficiently ventilated either by natural or technical means.

Forced ventilation is mandatory for underground rooms, accessible ducts or enclosed spaces.

The performance of forced ventilation is sufficient if in rooms or ducts an air change rate of 3 to 5 per hour is achieved. Capture devices have to be located directly under the ceiling and above the floor.

Rooms above ground floor are considered sufficiently naturally ventilated if at least two non-lockable openings are positioned on opposite outdoor walls, one of them directly above the floor and the other directly under the ceiling. Each opening must have a minimum size of 20 cm^2 per 1 m^2 floor space and may be no smaller than 100 cm^2.

Biogas reactors/Fermenters

During charging of a biogas reactor/fermenter it must be guaranteed that workers are not exposed to leaking biogas.

If an employee needs to enter a vessel for charging, unloading, etc., it must be guaranteed that all parts of the vessel are in a safe state and that they cannot start moving by themselves.

The air must be tested from the outside before entering the vessel to exclude the presence of toxic gases such as carbon dioxide and hydrogen sulfide, as well as to validate that the oxygen content is within safe limits. In addition, the concentration of flammable gases must be measured in order to ensure that there is no explosive atmosphere present.

Storage of biogas

The gas storage device has to be designed in a way that leakage of biogas caused by damage of the membrane due to thermal, mechanical or chemical factors, or to UV-radiation, is prevented. Enclosure of the gas storage device is a typical prevention measure. The storage device must be checked periodically.

Utilisation of biogas

In rooms where biogas powered engines, microturbines or boilers etc. are placed, only the mandatory equipment such as valves, arrestors or shut-off-valves should be installed in the gas line.

In areas around condensate traps, gravel filters, booster fans or coal filters, an explosive atmosphere may occur. Therefore, this equipment should be placed outside the area where the gas is used, typically in a separate room.

Biogas plants must be equipped with at least one flaring device or one additional gas consuming device capable of burning the entire biogas production in case of a failure of the primary gas utilisation device or of the biogas treatment unit for feeding into the natural gas network.

Further literature

HSE: A guide to the Gas Safety (Management) Regulations 1996

HSE: Research Report RR 882: Hazards arising from the conveyance and use of gas from Non-Conventional Sources (NCS), 2011

EPA: Common Safety Practices for On-Farm Anaerobic Digestion Systems, 2011

Cornell University ILR School: Conducting a Safety Walk-through on a Farm: Hazards of the Manure Handling System, Anaerobic Digester, and Biogas Handling System (A Self-Assessment Guideline for Farmers), 2007

RM Data Sheet Biogas/0315: Risk Management Programme for Biogas Production by anaerobic digestion

Published by:
IVSS Sektion Chemie
Kurfürsten-Anlage 62
D-69115 Heidelberg
Germany

IVSS Sektion Maschinen- und Systemsicherheit
Dynamostraße 7–11
D-68165 Mannheim
Germany