KITO Armaturen GmbH

QUALITY · PROTECTION · SAFETY

KITO® - Explosion protection concepts for agricultural biogas plants

General information

A biogas plant is primarily used for the production of biogas by fermentation of biomass. Biogas plants are important producers of electricity and heat from renewable energies.

Biogas is a gas mixture consisting mainly of methane and carbon dioxide as well as steam and various trace gases. One of these is the equally flammable gas hydrogen sulphide. The average composition of the two main components in biogas can vary from 50 - 75 vol. % for methane and 25 - 45 vol. % for carbon dioxide depending on the input materials and the production process. Biogas is a flammable gas that can form explosive mixtures when mixed with air. An explosive mixture is present if the concentration of biogas in the air is between 6 vol. % (LEL) and approx. 22 vol. % (OEL).

For the safety analyses is used the explosion triangel as shown in Fig. 1.

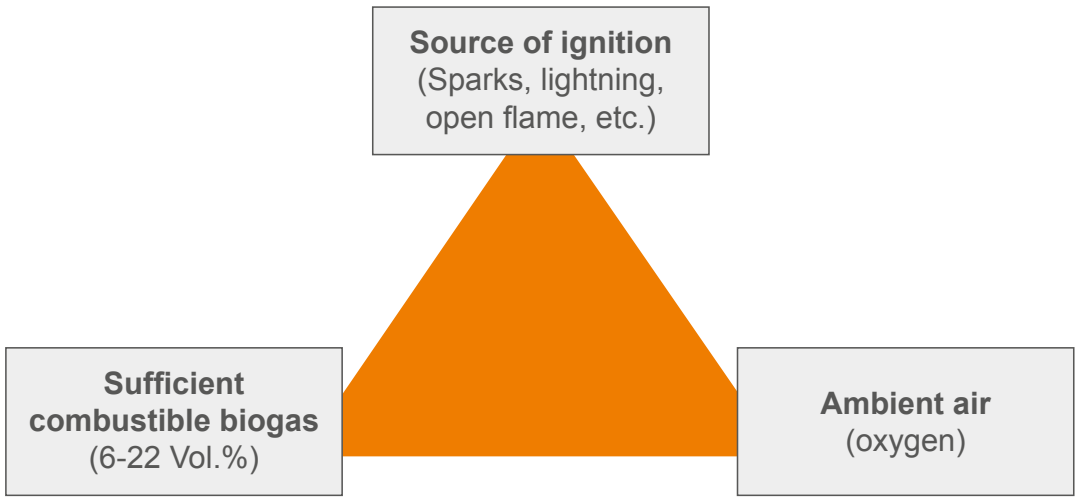

Fig. 1: Explosion triangel

To avoid an explosion, one of these components must be removed or prevented by suitable measures. In the event that the formation of explosive mixtures or their ignition cannot be prevented, explosion propagation must be reduced to an acceptable level by appropriate protective systems such as flame arresters.

According to ATEX 99/92 EC, the potentially explosive areas of application are divided into hazard zones. The hazard zone indicates the probability of an explosive atmosphere may occur. A distinction is made between zones for flammable gases (zones 0, 1, 2), whereby with zone 0 the potentially explosive atmosphere does occur continuously, over long periods or frequently, with zone 1 in normal operation occasionally and with zone 2 normally not or only during a short period.

Depending on the Maximum Experimental Safety Gap (MESG) (measured according to IEC 60079-2-1:2010) gases and vapours are classified into explosion groups IIA1, IIA, IIB1, IIB2, IIB3, IIB and IIC according to ISO 16852. Biogas is classified in explosion group IIA 1. Due to the inerting effect of carbon dioxide in biogas, it is less critical than pure methane. For the classification of hazardous areas or assesment of the risk of explosion need to be considered also the start-up and shutdown of the system, normal operation and the occurrence of expected operational faults.

KITO® Explosion protection

The interior of continuously operated fermenters in agricultural biogas plants is currently classified in Zone 1 by the German Commission for Plant Safety (KAS - 12). Certain operating conditions, e.g. during commissioning, start-up and shutdown or repair and cleaning work, may result in the occurrence of an explosive atmosphere in accordance with hazard zone 0 or 1. For desulphurisation by air injection up to a maximum of 12% air in normal operation, the gas space of the fermenter is considered zone 0.

KITO® recommends due to the lack of inertization during the commissioning as well as the air supply during start-up and shutdown process to classify the interior of the fermenter in zone 1.This means that the pressure relief and vacuum valves on the vessel must be explosionproof and meet the requirements and conformity in accordance with EN ISO 16852 or EU Directive 2014/34/EU.

In the case of gas desulphurisation, the formation of explosive atmospheres for the different desulphurisation processes should be examinated separately. If an explosive atmosphere may be formed by the addition of air, a protective measure like flame arrester shall be provided to prevent a propagation of the explosion.

The protection of the possible operational ignition sources such as the emergency flare system, the gas engines and the CHP is carried out by in-line deflagration flame arrester. In this case, the flame propagation velocity accelerates below the speed of sound and the installation location must not exceed the maximum permissible L/D ratio (L= distance from the ignition source to the installation location of the deflagration flame arrester, D= diameter of the pipeline). The maximum permissible L/D ratio can be found in the operating manual. The use of in-line detonation flame arrester is independent of the installation location, as they are also tested for in-line deflagrations in accordance with the EN ISO 16852 standard.

Detonations are explosions that propagate at a supersonic rate. Fig. 2 shows an example of the protection of an agricultural biogas plant. The KITO® devices for use in agricultural biogas plants are listed below (Fig. 2).

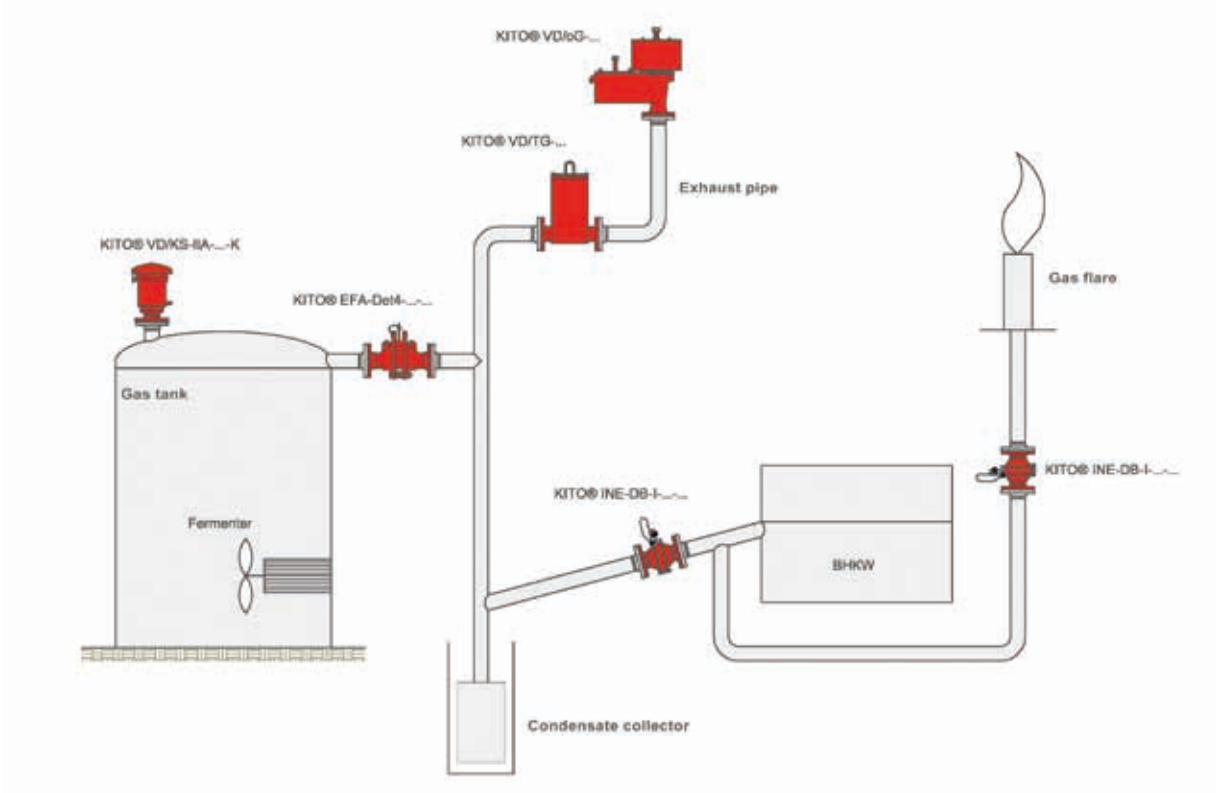

Fig. 2: Exemplary protection concept of an agricultural biogas plant

KITO® devices

1) Pressure and vacuum relief protection of the fermenter with classification of the interior in zone 1

Deflagration- and endurance burning proof pressure and vacuum relief valve KITO® VD/KS-IIA-...-...

2) Pressure and vacuum protection of the fermenter with classification of the interior in zone 2

2.1 Installation in the pipeline

KITO® Pressure and vacuum relief valve VD/TG-...

2.2 Alternative to installation as end-of-line valve

KITO® Pressure and vacuum relief valve VD/oG-...

3) Protection of emergency torch, gas engines, heat- and power plant with a in-line deflagration flame arrester, endurance burning proof

Bi-directional in-line deflagration flame arrester, endurance burning proof KITO® INE-DB-I-.../...

4) Absicherung der gaszuführenden Leitung with in-line detonation flame arrester

Bi-directional in-lin detonation flame arrester, short-time burning proof KITO® EFA-Det4-...-.../...

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