International Gas Union Research Conference 2011

BIOMETHANE GAS GRID INJECTION

CASE STUDY

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Abstract

This work describes the first biomethane production plant (BioGn) in Portugal and points out the constraints on and difficulties in implementing it.

Biomethane is not yet produced in Portugal, though it is in other European countries, particularly in Sweden, the United Kingdom, the Netherlands, Austria and Germany. European measures have been established to encourage the introduction of biomethane in natural gas networks, e.g. European Directive 2003/55/EC [Directive 2003/55/EC of the European Parliament and of the Council of 26 June 2003].

As yet there is no European legislation on technical standards for biomethane production, and so each country creates its own quality standards and techniques, and any incentive system it may consider suitable. Germany, for instance, which was the first country to produce biomethane, in 1992, included regulations for introducing biomethane into natural gas networks in its 2008 energy program. The regulations include technical quality standards and details of the relevant remuneration and incentive systems [German: Erneuerbore-Energien-Gesetz].

1. Introduction

The biomethane production plant will be installed in the Sermonde landfill site. It will handle the cleaning and purification of biogas produced in an organic waste recovery waste plant (OWRP).

The landfill caters for two cities, Santa Maria da Feira and Vila Nova de Gaia, a geographical area of 384 km2 and a population of 462 681. This area produced 180 379 tonnes of MSW in 2006.

1.1. Biogas production

The OWRP can treat 20 000 tonnes of biowaste a year, recovered from 43 000 tonnes of undifferentiated MSW. The OWRP will consist of a reception stage, followed by mechanical pre-treatment, digestion, storage and handling of biogas, dehydration, composting and exhaust air treatment system.

The anaerobic digestion stage will use BTA technology (Biotechnische Abfallverwertung GmbH & Co. KG), consisting of a suspension tank, two vertical digesters (2.250m3 each), a mixing system based on the recirculation of biogas produced by mesophilic digestion (36 to 38 °C) with a retention time of 24 days.

Biogas produced by the anaerobic digestion of MSW recovered is collected and stored in a gasometer of 4 000 m3 capacity. Downstream of this reservoir the biogas is cooled to 6 ºC.

The plant is expected to produce 2 654 400 m3 (3 229 tonnes) of biogas a year, corresponding to a flow of 316 m3 / h, with the characteristics listed in the table below.

TABLE I – Composition of biogas produced by OWRP.

Parameters	
Methane content	Exceeding 60%
Carbon Dioxide content	Less than 40%
Nitrogen content	Less than 15%
Oxygen content	Less than 1%
Hydrogen sulphide content	Less than 500 ppm
Residual values of "halides" (derived halogenated hydrocarbons) and organic compounds, other than methane, content	Less than 100 ppm
Humidity	Less than 5%

The biogas will be delivered at a pressure of 70 to 100 mbar and a temperature of 15 to 30 °C.

1.2. Biomethane production

The cleaning and purification process is based on PSA with a pre-phase removal of hydrogen sulfide, and involves two main operations: removal of hydrogen sulfide; removal of carbon dioxide.

Hydrogen sulfide removal involves a tower cleaning, followed by a bio-reactor. The biogas enters the clean column and the hydrogen sulfide content is removed by means of a countercurrent flow (water). The alkaline water absorbs hydrogen sulfide and is then regenerated in the bioreactor before returning to the cleaning column. The H_2S (hydrogen sulfide) content is reduced from 1500ppm to 100ppm.

The removal of carbon dioxide by the PSA method (Pressure Swing Adsorption) operates at two pressure levels. Impurities are adsorbed at high pressure to increase the partial pressure and thus increase the adsorption of contaminants from the adsorbent material. Regeneration occurs at low pressure to reduce the residual adsorbed components and to achieve a product of high purity, high adsorption / regeneration capacity, and finally a high content of methane gas.

The carbon dioxide removal process requires six adsorbent canisters, supply of adsorbent material, including activated carbon.

During the operation each canister works alternately in adsorption, regeneration and change in pressure.

During adsorption the biogas enters the canister through its base. The biogas flows through the canister and CO_2, O_2 and N_2 are retained on the inner surface of the adsorbent material, with the methane-enriched gas exiting through the top.

Before the adsorbent material is fully saturated by contaminants, the adsorption phase is stopped and another adsorbent vessel, previously regenerated, is automatically activated in adsorption mode, thereby ensuring a constant production of biomethane.

The adsorbent material is regenerated by gradual depressurization of the adsorbent canister to atmospheric pressure, and then to vacuum state. Initially, depressurization is achieved through the balance of pressures with another already-regenerated canister. This stage is followed by a second depressurization in which pressure almost reaches atmospheric pressure. The gas leaves the adsorbent canister at this stage; it still has high methane content and it is recirculated to the compression stage.

The biomethane produced has the features listed in the table below.

TABLE II – Composition of the biomethane produced.

Parameters	
Temperature	20 – 40ºC
Pressure	4 bar
Methane	>95%
$CO_2+O_2+N_2$	<5%
H_2S	<3 mg/m3
Ponto de Orvalho (a 5 bar)	<-60ºC
Relative Density	0,59

2. Constraints

The project described above, which was considered a PNI (Project of National Interest), is currently under implementation. The main constraints on the development of the project are the lack of legislation to regulate and standardize the process, particularly with respect to the quality of the biomethane injection into the natural gas network, the absence of a system of incentives and knowing what charges to apply.

3. Suggested solutions

A quality specification was developed under the project to deal with the constraints, and it is recommended that a fee should be paid for biomethane.

3.1. Quality specification

The proposed quality specification was drawn up bearing in mind both the technical specifications in use elsewhere in Europe and national requirements in relation to natural gas. The quality of the biomethane to be injected into the natural gas network can thus be regulated, for the benefit of consumers, end users, network integrity and the return from and condition of the end-use equipment.

In the case of injection into natural gas grid, biomethane must be governed by the same rules as those applied to natural gas and comply with the permitted ranges of variation. There should be monitoring of the concentration of oxygen, hydrocarbon dew point for pressures up to maximum working pressure, the concentration of carbonyl sulfide, the concentration of impurities and the minimum concentration of methane.

Taking into account the evaluation of different contaminants in the biomethane, the standards defined by legislation, standards adopted in other countries and also the characteristics of natural gas sold in Portugal, the specifications for the injection of biomethane into the natural gas grid in Portugal may be characterized as shown below.

TABLE III – Biomethane specifications proposal.

Parameters	Units	Biomethane specifications
Maximum Wobbe Index	(MJ/m^3)	57,66
Minimum Wobbe Index	(MJ/m^3)	48,17
Higher calorific value	(MJ/m^3)	42
Net Calorific Value	(MJ/m^3)	37,9
Methane	(% vol.)	> 80
Density	----	0,5549-0,7001
Relative Humidity		< 60 %
Dew Point	(ºC)	- 5ºC
Water	(mg/m^3)	< 5

Particles	(% vol.)	< 6
CO2	(% vol.)	< 3
O2	(% vol.)	< 2
CO	(% vol.)	< 5
H2	(mg/m^3)	< 5
H2S	(mg/m^3)	< 100
NH3	(mg/m^3)	< 50

The proposal has received positive responses from authorities.

3.2. Incentives

In terms of incentives, standards or charges, it is proposed that a fee should be paid for biomethane, depending on the technology and resources used, along similar lines to the production of electricity by ERF.

The figure of natural gas producer in a special regime (renewable natural gas), i.e. natural gas production from renewable sources, is not established in Portuguese legislation. However, as in the electricity market, a model can be defined to prepare the natural gas market for the production of renewable natural gas, establishing the licensing of facilities and market relations, as well as rates of return on green energy.

The proposal is being assessed by the competent authorities.

Bibliography

Directive 2003/55/EC of the European Parliament and of the Council of 26 June 2003.

German: Erneuerbore-Energien-Gesetz; EEG; section 9.