BIOGAS
CHP

TILBURG
THE NETHERLANDS

Biogas is one of the most common renewable energy resources. It can be produced by the anaerobic fermentation of wood or agricultural waste, on landfills or in sewage plants. These last two ways of producing biogas are the most interesting for cities in their policies of promoting renewable energies. The use of biogas is also interesting economically already in the year 2000, it is one of the cheapest renewable energy sources. It is often burned in combined heat and power plants, but it can also be injected into local, natural gas networks. In Tilburg, in The Netherlands, a municipal association initiated a complex of a landfill gas installation, a biogas plant, and an upgrading plant has been running since 1994. The upgraded gas, which has natural gas quality, is injected into the natural gas network.

GENERAL ASPECTS

Tilburg is a city located in the South of The Netherlands, including 190,000 inhabitants. The city was earlier the centre for textile production in the country but, due to lower costs of labour in other parts of the world, this has changed.

Today a famous textile museum is the only thing left from this era. Tilburg has now a diversified industry making it less dependant on one industry.

Climatic data:
Degree days (Basis 18 °C): 2,760
Annual mean temperature: 10.9 °C

CONTEXT

Since 1994, the Dutch municipalities have been obliged to collect waste from organic origin, separately from other forms of waste. The technology that is used commonly to treat this waste is aerobic digestion for compost production. By using this waste in an anaerobic digestion plant, biogas can be produced as well. However, little experience with this kind of large scale waste treatment was available in the Netherlands. The main objective of the project was to evaluate the technical, the economic and energetic performance of the biogas technology and to evaluate the environmental aspects as well. An association has been created involving 9 municipalities, of which Tilburg is the largest. The name is SMB (Samenwerkingsverband Midden Brabant) and the objective was to solve the waste problem in the cities. In total, the 9 municipalities have 480,000 inhabitants, who yearly produce 40,000 tons of organic waste. As a landfill biogas treatment plant was already present in Tilburg, SMB chose anaerobic digestion of the organic waste, which means Vegetable, Fruit and Garden waste, (VFG). Anaerobic digestion is the decomposition of organic matter in an anaerobic environment.

EXPERIENCE OF TILBURG

The handling of waste from the inhabitants of the nine municipalities in the North-Brabant Province, is taken care of by the municipal association, SMB. All installations are owned by SMB. The complex consists of an old landfill where landfill gas, since 1985, has been extracted, a new biogas plant where all VFG waste is now being handled, and an upgrading plant where landfill- and biogas are upgraded/cleaned to natural gas quality and fitted into the extensive gas network in the region. The degradation, which is done in several stages using specific bacteria and conditions, including a specific temperature, permits the production of a biogas with a high content of methane.

The VGF digestion plant

The biogas plant is built on the basis of the VALGORA-process. After arrival, the VFG waste is pre-treated by means of shredding, screening and iron separation. The digested material is processed into compost by dehydrating and sand separation. Before using the compost as a soil structure improving material, it needs to be further processed (maturing, screening). The waste water is partly re-used processing water and the remaining waste water is drained to a nearby waste water treatment plant.

The anaerobic digestion plant includes the following units:

- VFG preparation unit, including: reception of waste, inert removal and size reduction.
- Anaerobic digestion unit, including: mixing of VFG waste, pumping into the 3,300 m^3 spelling digesters, biogas buffer storage, compression and stirring system, digested matter extraction and the mechanical de-watering.
- Process water treatment unit, including: compost storage unit, which includes a completely closed building in which the digested matter is kept for a seven days period, and an open building under which compost can be stored one more week before being transferred to users.
- Extraction and treatment installation dealing with foul air coming from the compost storage unit and other installations.

Technical figures describing the biogas plant are the following:

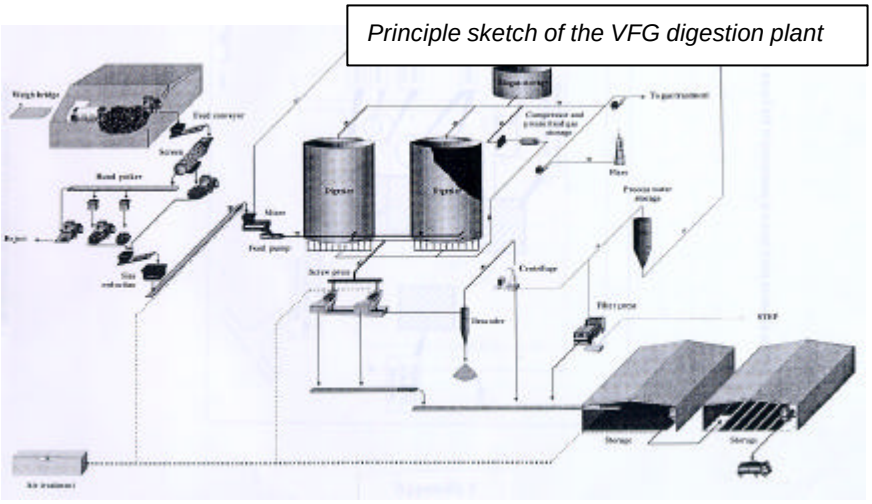
- Digestion temperature: 37-40 °C
- pH: 7.1
- Retention time: 24 days
- Organic volume load: 7.0-8.6 kg VDM[1]/m^3*day
- Methane content: 55 %
- Methane production: 200-250 Nm^3/tons VDM
- Annual Capacity: 52,000 tons of VFG
- Annual Load: 40,000 tons of VFG

The biogas productivity is around 75 Nm^3 biogas per ton received VFG. This productivity varies during the year; it increases during the winter and decreases during summer. The investment to the biogas plant was approximately 16 million €. The agency for energy and environment in The Netherlands, Novem, granted approximately 1.4 million €. – the rest was

[1] VDM: Volatile Dry Matter

invested by SMB. The "cost of digestion" has until now been 65 €/ton of VFG – this figure includes the gains from sales of the biogas and the compost. In comparison to "normal" aerobe digestion process, these costs are higher, but regarded however as acceptable due to the environmental aspects and the energy performance. So far, the VFG digestion plant has produced 3.0 million Nm^3 biogas per year – with a methane content of approximately 55%. This is converted /upgraded in the upgrading plant to 1.6 million Nm^3 of gas with "natural gas quality[2]".

Principle sketch of the VFG digestion plant



Afterwards it is transferred into the gas distribution network. The yearly energy production is 18 GWh, of which 3.3 GWh (300,000 Nm^3 of natural gas) is used for process heat at the plant itself which means that 14.7 GWh is sold to the gas distributor. The hydrogen sulfide content (H_2S) observed in the biogas at Tilburg is very low (from 0 to 100 ppm). If it is assumed, that the biogas is replacing natural gas for heat production, these energy and environmental figures can be calculated[3]:

Net biogas production	1,6 million	Nm^3/year
Energy	14.7	GWh
Saved CO_2-emmision	3000	Tons/year
Saved NO_x-emission	5.3	Tons/year

Currently, 12 people are employed at the VFG digestion plant. The plant produces 18,000 tons of digestant yearly (digested VFG). This digestive is completely stabilised. Heating and respirometry tests have shown that the organic amendment coming from the plant indicates a high maturity degree, and quality requirements for compost are met. But, because of lack of finances, the "after treatment plant" for the handling of the digestive to produce compost, was not built. This means that even though it is possible to produce high quality compost, this has not been done to date. Today, thoughts are centred on building this final part or placing this after treatment elsewhere, in relation to the permit.

The land fill gas site

The landfill has an area of 70 hectares and receives 190,000 tons of waste per year. The yearly extraction of land fill gas is approximately 7.5 million Nm^3. The waste dumped at the landfill may not be harmful in any way to the soil, water or air. For this reason the ground under the landfill has been thoroughly sealed off with a double layer of plastic foil, with, immediately beneath that, a virtually impregnable layer of clay. An extensive system of control and supervision ensures complete safety. The water that seeps through the waste heap is collected in an extensive drainage system. – A unique inspection tunnel which runs straight through the waste heap makes the control easy. In addition, harmful waste is also

[2] Defined as gas having a burning value as natural gas, 10 kWh/Nm^3
[3] If it is assumed, that the biogas is replacing the burning of natural gas.

given special treatment; it is stored separately in isolated compartments. If a certain part of the landfill becomes full, the area is wrapped up like a spring roll and sealed off with a double layer of foil, making it completely insulated from outside influences.

The upgrading plant

The upgrading plant was built in 1986, when utilisation of the gas from the landfill began. It receives biogas from three different sources; the landfill site, the VFG digestion plant and a neighbouring sewage treatment plant that from time to time delivers surplus biogas. Normally, this plant uses its biogas in a small co-generation unit. On a yearly basis, 30% of the handled gas is from the VGF digestion plant and 70% from the landfill site. The treatment plant includes a humid washer to remove carbon dioxide by gas-liquid contact. Some of the surplus CO_2 is used for cleaning purposes, the rest is emitted into the atmosphere. Biogas treated to reach natural gas characteristics is injected into the Tilburg City distribution network. The total investments in 1986 were amounted to 3.6 million €. Up to the moment, the production price has been 0.14€/Nm^3. Regarding technical specification[4] the following should be mentioned:

- Maximum capacity (Input, biogas) 2000 Nm^3/h
- Maximum capacity (output, upgraded gas) 1300 Nm^3/h
- Normal load (biogas): 900–1700 Nm^3/h
- Yearly production (upgraded gas): 6 mio. Nm^3

EVALUATION AND PERSPECTIVES

The prices paid, at the moment, for biogas and compost do not show the clear environmental advantage in digesting organic waste at an anaerobic digestion plant. This fact, compared with high maintenance costs due to a complex waste composition, which, from time to time, contains large amounts of sand which produces wear and tear to the plant, resulting in a not optimal economy. Aerobic composting is a competitive technology with fewer environmental benefits, however lower treatment costs, though in advance with waste producers. The future of the SMB VGF digestion plant is under discussion, complementary investments and increase of input are necessary in order for it to become economically acceptable.

FOR FURTHER INFORMATION

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[4] Average from the years 1996 to 1999