BIOMASS CHP PLANT GÜSSING: SUCCESSFUL DEMONSTRATION OF THE STEAM GASIFICATION PROCESS

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1. Güssing: European Centre of Renewable Energy

The town of Güssing, situated in the south – easterly corner of Austria, was one of the poorest regions of the country, marked by high unemployment and migration. In the year 1991 the community of Güssing set up a new energy concept, which included the coverage of the total energy demand by local biomass. Since that time this concept has been consequently implemented. Therefore a bio diesel plant and a district heating system, based on biomass, were installed. 95% of the heat demand and more than 100% of the fuels, which are needed in the region, are now produced from renewables. As a result of these efforts in the area of renewables, a "European Centre for Renewable Energy" was established in Guessing.

The latest plant of this successful row was a biomass fuelled CHP plant, based on a steam blown gasifier, producing heat and power with a gas engine, with the capacity to cover the total electricity demand in Guessing. Since the start up of this plant Guessing has totally changed the energy supply to renewable sources.

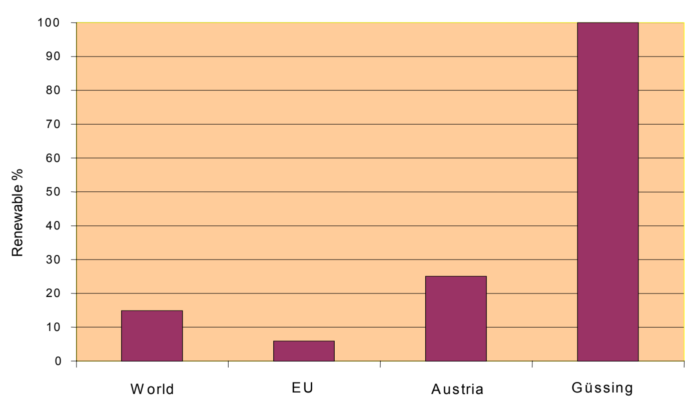

Figure 1: *Renewable Share of Total Energy Consumtion*

2. Process Description

A new type of power plant was specially designed for the production of electricity at small, decentralized sites. A gasification process, which has explicit advantages over combustion at combined heat and power (CHP) applications, has been utilized. 1.760kg of wood per hour produce 2.000 kW electricity and 4.500 kW district heat.

Steam Gasification:

As gasification technology a steam blown fluidised bed gasifier is used, which produces a nitrogen free gas with a high calorific value (12 MJ/Nm3) and a low of tar content. The heart of the plant, the fluidized bed steam gasifier, consists of two connected fluidized bed systems. In the gasification zone at approximately 850°C the biomass is being gasified with steam. By utilizing steam instead of air as gasifying agent a nitrogen free product gas with a low tar content and a high heating value is produced.

To keep the energy balance for the gasification process additional heat has to be fed into the gasifier. Not completely gasified carbon (charcoal) is partly fed into the combustion zone together with the circulating bed material, which serves as a heat carrier, and is burned. The exothermic reaction in the combustion zone provides the energy for the endothermic gasification with steam. Two separated gas streams are produced: a flue gas stream, comparable to flue gases from a conventional combustion and the product gas stream. The containing heat of the two gas streams is used for the production of district heat.

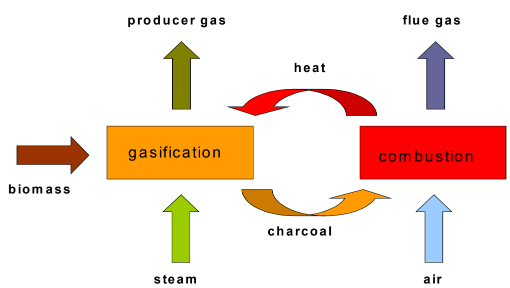

Figure 2: principle of the gasification

Gas Cooling and Cleaning:

When applying a gas engine it is necessary to cool down and clean the product gas. A gas cooling and a two stage gas cleaning system makes sure that the gas engine gets a proper gas. The gas is dedusted in a fabric filter. The seperated dust is recycled to the combustion chamber to utilize the contained carbon. In the following scrubber the concentrations of tar, ammonia and acid gas impurities are reduced.

As the gas is further cooled water and tars are condensed.

The condensing water is utilized to produce the steam for the gasification process. In this way all residues can be recycled. Therefore, the gas cleaning process works free of residues and waste water or condensates.

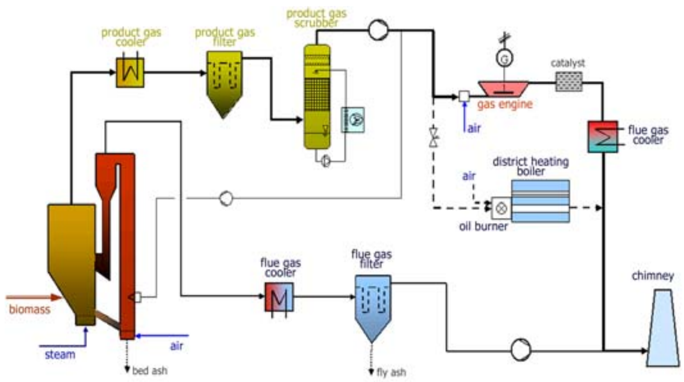

Figure 3: *Process flow diagramm*

Gas Engine:

The gas engine converts the chemically energy of the product gas into electricity.

It is a turbo-charged “Otto”-type engine from GE Jenbacher which had been specially adapted to the properties of the producer gas. The flue gas of the gas engine is catalytically oxidised to reduce the CO emissions. The dissipated heat of the engine is used for district heating. Thus, efficiencies are achieved which were unreached in biomass usage until now.

The electrical efficiency is app. 25 %. The total efficiency (electricity and heat) even obtains 80%. The plant has a fuel capacity of app. 8 MW and produces 2 MW of electricity and 4,5 MW of district heat, which is fed into the heating grid.

The total investment for the plant was app. 9 million €.

3. Operation Results

After roughly two years of operation the plant has fulfilled all the expectations. It worked well for over 11.000 hours, shows a very constant and stable operation. From the very first moment the constancy of the gas composition and heating value were impressive. The insensibility on the water content of the fuel, which is a major advantage of the steam gasification enables a stable composition. The gas cleaning process has proven to be reliable and fail-safe. Even after 8.000 hours of operation no deposits inside the engine could be found. The maintenance costs of the engine are in the range of natural gas fuelled gas engines.

By producing large quantities of heat and electricity the full commercial operation of the plant could be proven.

4. Further R&D Works

The favourable characteristics of the product gas (low nitrogen content, high hydrogen content) make it a preferred source for high sophisticated gas usage. Research projects concerning the production of SNG (synthetic natural gas), Fischer-Tropsch Diesel and electricity in a SOFC (solid oxide fuel cell) have been started.

Fischer Tropsch Synthesis

Within the EC-project RENEW (Renewable Fuels for Advanced Power Trains) in the 6th Framework programme a bypass flow of about 10Nm³/h will be converted via Fischer-Tropsch synthesis into diesel. The gas will be taken after the existing gas treatment, compressed to 20-25bar, cleaned from sulphur and chlorine components and converted in a slurry reactor to waxes. From these waxes the diesel will be produced via hydrotreating. The FT-reactor should be finished till end of 2004 and in spring 2005 first results are expected.

Methanation

The work is done in co-operation with the Paul-Scherrer Institute from Switzerland.

A test rig for methanation was designed to perform experiments in a 2 kW scale. The most promising catalyst then was used in an experiment with a slip stream of the FICFB gasifier in Guessing during summer 2003. After more than 120 h on stream the catalyst still showed an outstanding performance. Under the heaviest conditions more than 98% CO-conversion and 99% tar-conversion to methane was achieved. Based on these results from the experiments the next step is to run long term experiments at the Güssing plant.

SOFC

This work is performed together with the Austrian Bioenergy Center and with the Department of Energy and Process Engineering, NTNU in Trondheim.

Coupling of a solid oxide fuel cell (SOFC) with a biomass gasifier gives electric efficiencies up to 43% and overall efficiencies of more than 80%. These high efficiencies can only be reached, if the gas cleaning is done at high temperatures. Therefore the work programme focuses also on the removal of dust, chlorine and sulphur components in a temperature area of 500-800°C. At the moment fundamental research is going on, first tests can be expected in early 2005.