

SUMMARY

20-21 of September 2007 Swedish Gas Centre (SGC) arranged an international seminar on gasification and methanation in Gothenburg. In total 17 speakers were invited to give presentations and the seminar was chaired by Staffan Karlsson, SGC. The seminar was divided into three parts

- International R&D activities
- National R&D activities
- Study tour to Rya CHP plant and Chalmers CFB-furnace

Rya is a gas fuelled CHP plant based on combined cycle technology, i.e. a gas turbine in combination with a steam turbine. Rya has three SGT800 gas turbines, from Siemens in Finspång, in parallel and a steam turbine. In the plant 600 MW natural gas is converted into 260 MW electricity and 290 MW heat. The heat is distributed through the district heating system in Gothenburg.

Chalmers CFB-furnace is complemented with a 2 MW indirect gasifier by Metso Power to enable syngas production.

BACKGROUND

Production of synthetic fuels through gasification of biomass is expected to develop rapidly due to political ambitions related to the strong fossil fuel dependency, security of supply issues and climate changes. Techniques that offer a possibility to produce high quality fuels in an efficient and sustainable way are of great importance. Furthermore, fuels that can be used in applications developed for the fuels used today (natural gas, LPG, oil, petrol and diesel), seems like the most promising route in the transfer to a future sustainable energy system. In this context gasification is expected to play a central part.

TECHNOLOGY STATUS

Gasification of biomass has been successfully demonstrated in different projects during the years and several activities are on-going. Below are some plants related to biomass gasification and syngas production listed together with a lignite coal gasification plant.

Güssing (indirect gasifier):

The plant in Güssing, Austria, is based on indirect or allothermal gasification. The plant consists of one CFB-furnace and one BFB-gasifier. Heat is transferred from the CFB-furnace to the BFB-gasifier through the circulated bed material. In this way no nitrogen enters into the gas leaving the gasifier. The plant is semi-industrial and the major part of the gas is used in gas engines to produce electricity and heat. A minor part of the produced gas is used for research, development and demonstration purposes. In the European Bio-SNG project, partly financed through the 6th European Framework Programme, methane from wood chips will be demonstrated in Güssing. A 10 kW methanation unit developed by Paul Scherrer Institute, Switzerland, has been in operation in Güssing. Based on these results the concept will be demonstrated in the MW-scale during 2008 within the Bio-SNG project.

The gasifier has more than 32 700 hours of accumulated operation. The availability has increased every year since the plant was inaugurated in 2002 and is now approx. 90 %. Most of the earlier problems have been related to the biomass feeding system.

More information at <http://www.ie-leipzig.de/Bio-SNG/Index.htm>.

Freiberg (BTL)

The Carbo V-gasifier in Freiberg, Germany, is a two step gasifier. In the low temperature gasifier pyrolysis gas is produced. In the high temperature gasifier the pyrolysis gas is combusted and the hot gas is chemically quenched by the endothermic char reactions. This results in a tar free gas with a very low content of methane. A syngas well suited for production of BTL-fuels.

In 2001 BTL was produced from bio-syngas in laboratory scale in Freiberg. In 2005 long duration test (3,000 h) of BTL production was performed. A 45 MW BTL-plant (β -plant) is under commissioning. The β -plant is an intermediate step towards the next generation of BTL-plants involving a 600 MW plant (Σ -plant).

More information at <http://www.choren.de>.

Piteå (black liquor gasification)

The 3.5 MW pilot plant (DP1= development plant 1) in Piteå, Sweden, is an entrained flow gasifier. The gasifier is located at Energy Technology Centre, ETC, in Piteå just beside a pulp mill, Smurfit Kappa Kraftliner.

The gasifier has more than 2,700 h of accumulated operation. So far the produced syngas has been flared but in the next development step production of DME will be demonstrated. The concept is expected to be demonstrated in a large scale plant (DP2) somewhere in Sweden as well as in New Page, USA.

More information at <http://www.etcpitea.se> and <http://www.chemrec.se>

Värnamo (oxygen-blown pressurized gasification)

In the 18 MW plant in Värnamo, Sweden, the IGCC concept was demonstrated 1996-2000. The gasifier and the gas turbine have 8,500 h and 3,600 h of operation respectively. In the EC project, CHRISGAS, clean hydrogen-rich synthesis gas will be produced based on steam/oxygen-blown gasification of biomass, hot gas cleaning and steam reforming. The rebuilding of the Värnamo plant is expected to be completed in May 2009.

More information at <http://www.chrisgas.com> and <http://www.vvbgc.com>

Great Plains (lignite coal gasification)

Syngas production from lignite coal has been on-going since 1984 in the Great Plains plant, USA. The plant consists of 14 Lurgi moving bed gasifiers which produce approx. 15 TWh SNG per year.

Carbon dioxide and sulphur compounds are removed by a cold methanol wash (Rectisol). After the methanation, the SNG is compressed, dried and distributed through the national gas grid.

Ammonia, phenol and other by-products such as carbon dioxide are, besides SNG, produced in the plant. The carbon dioxide is used for enhanced oil recovery in the Williston Basin field.

More information at <http://www.dakotagas.com>.

TECHNOLOGY ROUTES

There are different technology routes available and the choice of technology depends on which product one is interested in. Gasification technology, process parameters (i.e. pressure and temperature), gas cleaning technology and synthesis process are some of the parameters that have to be considered and optimized for the specific product or combinations of products one is interested in.

It is not possible to say that one route is superior to another one since it depends on more than the production technology, i.e. economy (production and investment cost), infrastructure, market potential, political ambitions, subsidies, taxes, environmental ambitions etcetera. However, as the interest for biomass gasification increases the cost for the biomass will most likely increase, which is in favour of those technologies with high efficiency.

Biomethane or SNG

Efficiency: 60-70 %
Plant size: >10 MW (indirect gasifier)
Plant size: > 100 MW (oxygen-blown, pressurized gasifier)

Biomethane produced through gasification and methanation is associated with high efficiency, the possibility to use the gas grid for distribution and a way to replace/complement the use of natural gas. The SNG-technology has been successfully proven in large scale applications fuelled with lignite coal (e.g Great Plains, USA). Still we are awaiting the first commercial SNG-plant fuelled with biomass.

Another advantage associated with bio-SNG production is a low financial risk. This is due to the possibility to build relatively small plants (compared to plants for DME and BTL-production) and the simple synthesis process.

DME

Efficiency: 50-60 %
Plant size: >100 MW

DME is just like biomethane or SNG a gaseous fuel. However, at a relative low pressure DME becomes a liquid and the volumetric energy content increases. DME is expected to replace/complement LPG and be distributed in the same way as LPG. DME is demonstrated as vehicle fuel in heavy duty trucks in Växjö within the EC-project DME Vehicle. In Sweden, DME-related research/activities are conducted in relation to the black liquor gasification pilot plant in Piteå and the Värnamo plant.

FT-fuels or BTL

Efficiency: 35-45 % (normally one obtains a distribution of hydrocarbons. In Freiberg approx. 70 % of the hydrocarbons are expected as synthetic diesel and 30 % as naphtha.)
Plant size: >100 MW

In the Fischer-Tropsch process carbon monoxide and hydrogen are converted into liquid hydrocarbons of various forms. The technology will be demonstrated at industrial scale in Freiberg, Germany, where a 45 MW biomass fuelled plant is erected. The BTL efficiency is lower than that for the biomethane and DME route. However, since liquid fuels dominate in the transportation sector, the market potential for BTL as vehicle fuel is orders of magnitude larger than the market potential for biomethane and DME as vehicle fuel. Synthetic diesel takes advantage of an existing retail infrastructure. Synthetic diesel fits any diesel engine. Contrary to fossil diesel synthetic diesel is bio-degradable.

Hydrogen

Efficiency: ~60 %
Plant size: >100 MW

If the aim is to produce hydrogen as raw material in chemical processes gasification of biomass may offer an efficient production route. However, if the aim is to produce a fuel for vehicles or CHP-production the hydrogen route is associated with many drawbacks compared to the bio-SNG route. The most obvious drawbacks are related to low volumetric energy content, high compression losses if used as vehicle fuel, hydrogen embrittlement and that the infrastructure for hydrogen as well as the applications have to be developed.

During the seminar the different routes were presented by the leading experts. The presentations give an excellent overview of the current status and what to be expected in terms of development, technical break through and commercialisation.

NOMENCLATURE

BFB	Bubbling fluidised bed
Biomethane	Methane produced from biomass (CH ₄)
Bio-SNG	Substitute natural gas produced from biomass
BTL	Biomass to liquid
CFB	Circulating fluidised bed
CHP	Combined heat and power
DME	Dimethyl ether (CH ₃ OCH ₃)
FP6	6 th Framework programme
FT	Fischer-Tropsch
LPG	Liquefied petroleum gas
MW	Mega watt (10 ⁶ watt)
SNG	Substitute natural gas
TWh	Tera watt hour (10 ¹² watt hour)

Jörgen Held
Director Swedish Gas Centre