ECN

Energy research Centre of the Netherlands

BioSyngas

Introduction

Synthesis gas (shortly: syngas) contains mainly hydrogen (H_2) and carbon monoxide (CO), which can be used in a catalytic process to synthesize all kind of products such as methanol, oils, diesel, ammonia, methane, etc. Syngas can also be used as a source for pure hydrogen. Furthermore, syngas can be burned in e.g. a gas turbine to produce electricity and heat.

Annually, a total of about 6 EJ of syngas is produced worldwide, corresponding to almost 2% of the present total worldwide primary energy consumption. This even is 5% for the Netherlands. The syngas mainly originates from fossil energy sources like coal, natural gas and oil/residues. The present syngas market however, offers an excellent opportunity for a smooth transition from fossil fuel to biomass. Final products like chemicals, transportation fuels and power can become more sustainable if present systems (partly) operate on biomass instead of fossil fuels. The intermediate syngas then is called **BioSyngas**.

BioSyngas with Coal based technology

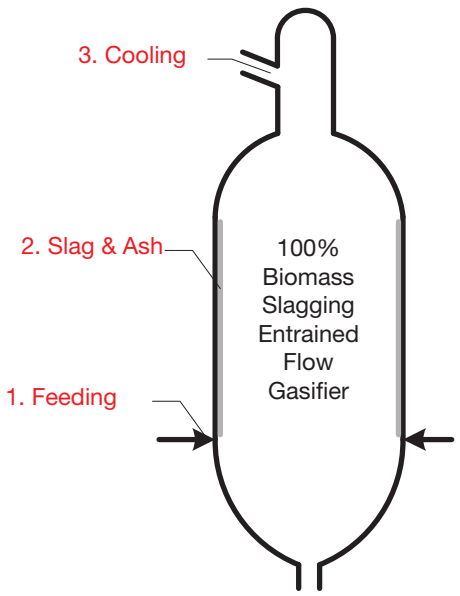
BioSyngas can be produced with existing coal-based technology. This includes high temperature processes such as **Entrained Flow** gasifiers, which operate at typically 1300-1600°C. Since most biomass is not suitable for direct injection into this kind of reactors, biomass **needs pre-treatment**.

Pre-treatment options include **torrefaction** where biomass is converted into a sort of coal, **pyrolysis** where biomass is converted into a liquid or slurry and **milling** of raw biomass.

Once pre-treated biomass (in solid, liquid or gaseous form) is inside the high-temperature reactor such as an entrained flow gasifier, issues related to inorganic compounds offer the next challenge.

Since biomass ashes are very different from coal ash, the slagging behaviour is different too. This means that other additives are needed to control the process. But it also means that cooler fouling issues change and increase.

ECN activities on BioSyngas focus on biomass feeding, slagging and cooler fouling issues and system assessment studies. We look at the transition from coal to biomass, where existing coal-based technology is a stepping stone for fast and large-scale implementation.



BioSyngas Developments at ECN

Biomass feeding: ECN operates a lab-scale pneumatic feeder to determine feeding behaviour of different mixes of (pre-treated) biomass and coal, ranging from 100% coal to 100% biomass.

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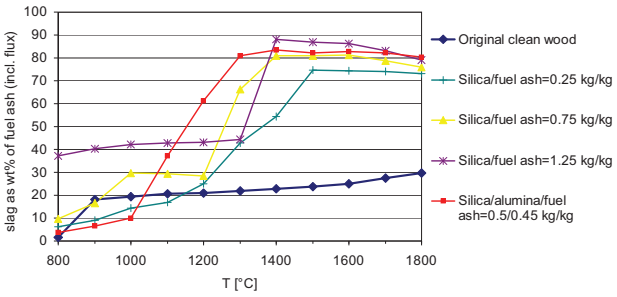
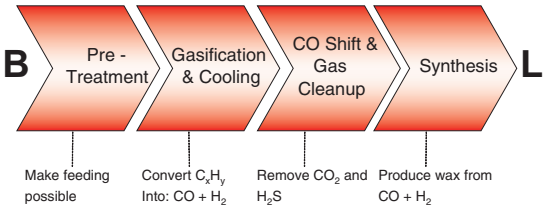
Slagging (melting) and fouling behaviour of biomass: ECN operates a facility (named “LCS”), in which various fuels can be tested under entrained flow conditions. Melting behaviour of fuel mixes can be tested and resulting slags are analyzed. It is now also possible to perform cooler fouling experiments under gasification conditions.

Tests are supported by thermodynamic models. Work reveals that ashes from clean wood are not prone to melting. Silica or clay is needed to decrease the melting temperature, see graph below.



System assessment: Different systems have been evaluated comparing various combinations of biomass pre-treatment, biomass transport, gasification, cooling, gas cleaning, and fuel synthesis. Focal point is system assessments for Biomass-To-Liquids (“BTL”), where Fischer-Tropsch diesel is produced from biomass. It revealed that pre-treatment is economically very attractive and torrefaction is amongst the most attractive options.



BioSyngas through reforming

The production of BioSyngas through reforming is done with fluidized bed or fixed bed gasification processes. Since these types of processes generally operate at moderate temperatures (below 1000°C), the outgoing gases contain significant amounts of hydrocarbon molecules such as methane, ethylene, benzene, and tars. These hydrocarbons can easily make up 50% of the energy content of the so-called **producer gas**. In order to convert the hydrocarbon containing gases into a syngas, a reformer is needed. This is a catalytic reactor where hydrocarbon molecules are converted into CO and H_2. An alternative way of destroying hydrocarbon molecules is a non-catalytic process at relatively high temperature. This could be similar as an entrained flow gasifier.

Reforming producer gas from fluidized bed or fixed bed biomass gasification processes is promising because of its potentially high efficiency. Activities within ECN focus on the first step of biomass gasification. This comprises the development of fluidized bed biomass gasification technologies such as the MILENA indirect gasifier. Synergies between our bioSyngas and BioSNG R&D are clearly present.

Our clients

Our clients include (petro)chemical industry, gasification industry, pulp and paper industry, investors, European Commission, national and local governments.

Further information

Check out our website: http://www.ecn.nl/en/bkm
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