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Bio Hydrogen

An investigation on the behaviour of nitrogen based impurities over a water gas shift stage and a biodiesel scrubber

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thermal gasification

Introduction & Motivation

The usage of hydrogen plays a major role in the chemical industry. Actually most produced hydrogen is based on fossil fuel. To fulfil the EU aims 2020 [1], H_2 was investigated as one possible source to replace fossil H_2 in the production process of fuels.

Materials & Methods

A hydrogen production plant was built as depicted in Figure 1.

This consists of a dual fluidised bed gasifier (DFB) to produce a hydrogen rich synthesis gas, a filter to remove particles out of the gas stream, a CO shift stage to convert carbon monoxide and steam to carbon dioxide and hydrogen and a biodiesel scrubber to remove water and tars (gas treatment stage). Following process stages are a CO_2 removal and a pressure swing adsorption (PSA) to separate high quality hydrogen. A steam reformer was installed to enhance the hydrogen yield.

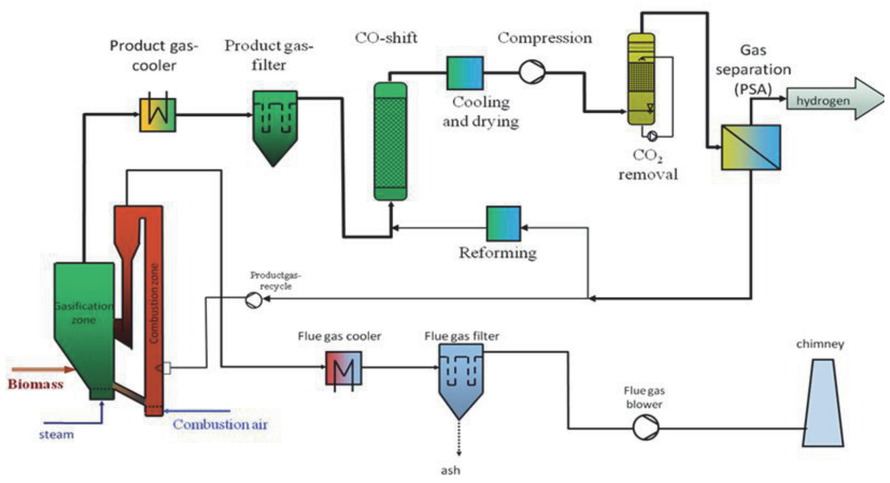

Figure 1: Flow chart of the hydrogen production plant in Güssing, Austria

To improve the economic viability a study, regarding nitrogen based impurities was done to get more information about influence of low quality feedstock on a hydrogen production plant. Therefor the gas treatment stage of the BioH_2 plant was operated.

Nitrogen formation

Nitrogen is bound in the fuel, so the feedstock quality is crucial for the amount of nitrogen based impurities in the synthesis gas. High quality wood feedstock has a mean of 0.35 wt-% (± 0,13) of nitrogen, while residue wood can have 1.05 wt-% (± 0,97) of nitrogen bound in the fuel particle [3]. Figure 2 shows the mechanism of nitrogen impurity formation during gasification.

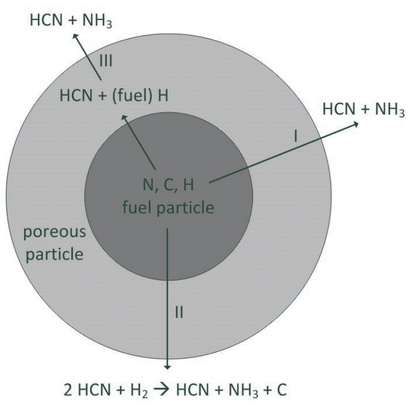

Figure 2: Formation of nitrogen impurities during gasification process [4]

Results & Discussion

A high temperature water gas shift stage, operated at atmospheric pressure connected with a biodiesel scrubber was used for the experiments.

Mass balances for NH_3 and HCN were developed. Figure 3 shows the Sankey diagram of the ammonia and hydrochloric acid behaviour over a water gas shift stage and a biodiesel scrubber.

It can be seen that HCN is hydrated over the CO shift reactors. An ammonia removal in the biodiesel scrubber caused by the condensation of process water can be observed.

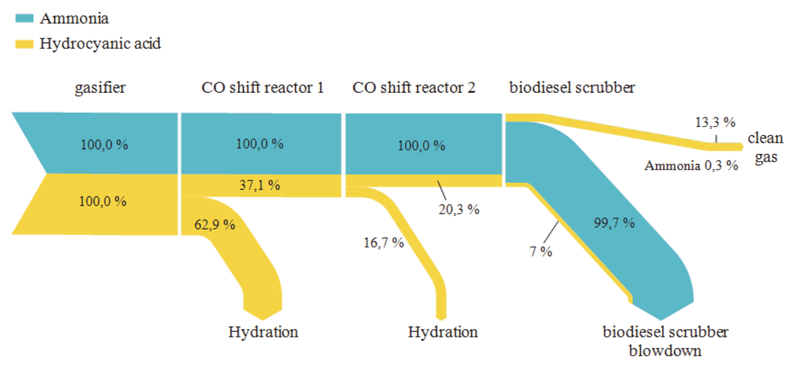

Figure 3: Sankey diagram of the ammonia behaviour over the plant

Conclusion & Outlook

Biomass to hydrogen from steam gasification seems to be a promising way in the production of biomass based hydrogen. The possibility of using lower quality feedstock for the gasification process was tested. It could be proved that it is possible to remove ammonia from the gas stream, before sensible process stages are affected. The bulk amount of HCN could also be removed. Therefor nitrogen based impurities can be seen as unproblematic if a switch to lower feedstock quality is done.

Future work should focus on long term tests including the whole process chain. Another possibility could be the usage of a low temperature CO shift stage integrated in a membrane module after the biodiesel scrubber to produce hydrogen in an alternative way. This membrane module is developed right now in an EC project called ROMEO.

Acknowledgment

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