Hydrogen from Biomass

UKCCSRC Web Event with IMechE: Hydrogen Production with Carbon Capture and Storage

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Advanced Gasification Technologies Study

AGT Study

- Advanced Gasification Technologies converting biomass and municipal solid waste to a range of fuel products: Hydrogen, Methane, Methanol, Fischer-Tropsch fuels
- Review of Current Status of AGT
- Review of Next Generation AGT
- Techno-Economic Analysis
- Focus on Opportunities and Barriers

Key Messages

- CO₂ balance should be studied further
- Realistic approach to feedstock availability and utilisation is required
- Technology is still at developmental stage

Advanced Gasification Technology Study

Biomass to Hydrogen Process Overview

- Biomass
- Feedstock Preparation
- Gasification
  - $O_2$
- Syngas Treatment
  - $CO_2$
- Water Gas Shift
- Purification
- $H_2$
Biomass to Hydrogen Process Overview

Typically includes as a minimum:
• Shredding
• Metals Separation
• Inerts Separation
• Drying

Feedstock Preparation ➔ Gasification ➔ Syngas Treatment ➔ Water Gas Shift ➔ Purification ➔ $\text{H}_2$

$\text{O}_2$ ➔ $\text{CO}_2$

Cheaper Feedstock ➔ Increased Contamination ➔ Increased Complexity ➔ Increased Risk
Biomass to Hydrogen Process Overview

\[ C_nH_m + O_2 + \text{Steam} \rightarrow CO + H_2 + \text{Steam} \]
Biomass to Hydrogen Process Overview

Treatment systems can include:
1. plasma conversion;
2. high efficiency cyclones for collection of entrained particulates and droplets of hydrocarbons;
3. wet scrubbing for the removal of entrained particulate matter, tars and NH₃;
4. activated carbon beds for adsorption of metals;
5. hydrolysis reactors for the reduction of COS, HCN and unsaturated hydrocarbons; and
6. amine scrubber for the removal of CO₂ and some acid gases.
Biomass to Hydrogen Process Overview

CO + H$_2$O $\rightarrow$ CO$_2$ + H$_2$

Low Temperature (200°C) - cobalt-molybdenum catalysts
High Temperature (500°C) - chromium or copper promoted iron oxide catalysts

CO$_2$ removal from shifted syngas by solvent based process, produces concentrated >90% stream
Biomass to Hydrogen Process Overview

- Feedstock Preparation
- Gasification
- Syngas Treatment
- Water Gas Shift
- Purification

**Flow Diagram:**

Biomass → Feedstock Preparation → Gasification → Syngas Treatment → Water Gas Shift → Purification → H₂

- Pressure Swing Adsorption
- Further purification as required
Biomass to Hydrogen AGT Developers

- Kew Technology
  - Feedstock – Densified RDF
  - Gasifier – Fluidised Bed
  - Product – Hydrogen, Electricity & Liquid Fuel
  - TRL - 6

- PowerHouse Energy Group
  - Feedstock – RDF, SRF & Mixed Plastics
  - Gasifier – Rotary Kiln
  - Product – Hydrogen & Electricity
  - TRL - 6
Opportunities

- Production of Low Carbon Hydrogen
- Carbon Negative Technology
Barriers

- Supply of sustainable biomass
- Conversion efficiency
- Product purity
- Product certification
- Value of CO$_2$
- Availability of technology
- Economics
Techno-Economic Analysis: Levelised Cost of Hydrogen

Figure 7: LCOH for biomass and waste with capture of the rich CO₂ stream
Conclusions

– Does this technology have potential to be part of the future energy system?
   Yes

– Will it solve all our problems?
   No, sustainable feedstock supply is limited and has other uses

– What is the technology for?
   Low Carbon Hydrogen? CO₂ Capture from atmosphere? Which will be the main revenue is unclear.
Any Questions?

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