

Plasma/catalytic gas cleaning to deliver high quality syngas from waste biomass

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- SUPERGEN Bioenergy Challenge II project
 - £0.91M, EPSRC project
 - 3 years starts 1st January 2015
- University Partners
 - Liverpool, Hull, Cranfield
- Industrial Partners
 - Thermitech Solutions Ltd., Future Blends Ltd, Alstom, Process Systems Enterprises Ltd, C-Tech Innovation Ltd

Biomass Gasification:

European Climate Foundation (ECF) Roadmap 2050;

“gasification as a major potential route for decarbonising power production.”

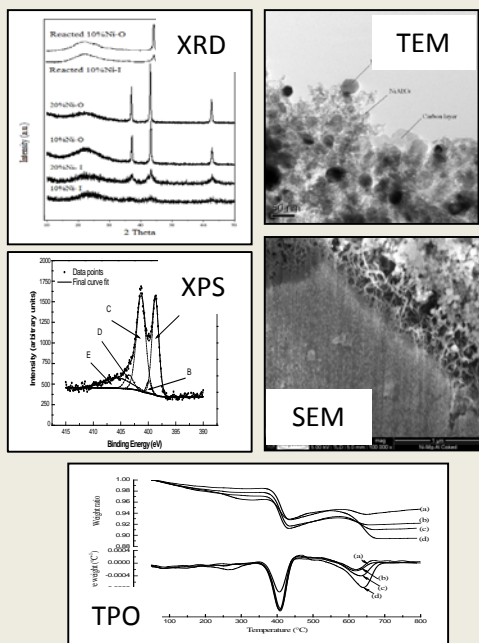
BUT:

- A key problem for biomass gasification is **tar** in the syngas.
- Tar causes major blockages in fuel lines, filters, engine nozzles and turbines.

Plasma Catalysis

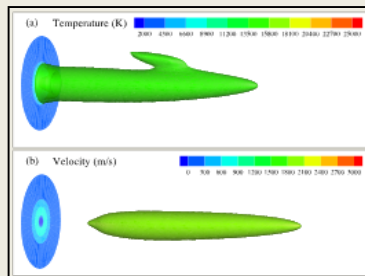
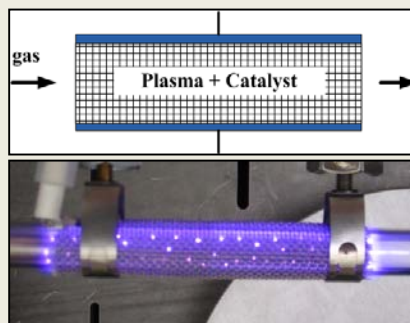
- Non-thermal plasmas: A low energy, “low” temperature (200-1000 °C) process
- Electrons in the plasma are highly energetic: Sufficient to break chemical bonds of molecules and high reaction rates
- The integration of plasma and solid catalysts, can generate a synergistic effect, reduce reaction temperatures, improve the activity and stability of the catalysts, enhancing reactant (tar) conversion
- Thereby, remove tar through a low energy, efficient, enhanced catalytic process

Catalyst Development



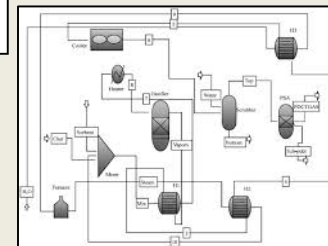
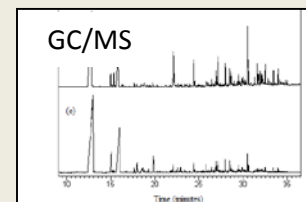
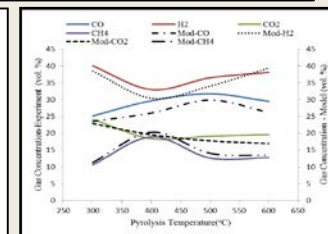
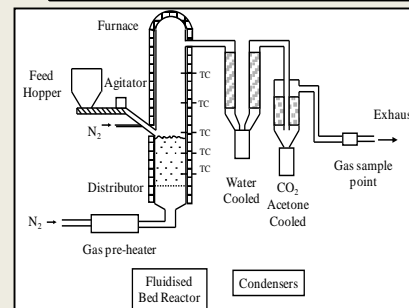
Plasma-Catalysis of model compounds

- Experimental
- CFD modelling



Fluidised bed gasification - catalytic plasma tar reduction

- Experimental
- Process modelling & simulation





- **Leeds** (Paul Williams):
 - Development of catalysts for tar removal from syngas
 - Fluidised bed biomass gasification with plasma catalytic tar removal
- **Liverpool** (Xin Tu):
 - Plasma reactor development
 - Integration with the catalytic reactor
- **Cranfield** (Sai Gu):
 - CFD modelling of the catalyst/plasma/tar interaction
- **Hull** (Meihong Wang; Chunfei Wu):
 - Whole system process modelling and simulation



- **Thermitech Solutions Ltd:**
 - Pyrolysis/gasification of wastes and biomass. Syngas cleaning systems for use in gas engines.
- **Future Blends Ltd :**
 - Pyrolysis/gasification of biomass and gas cleaning issues.
- **Alstom UK Ltd :**
 - Biomass power generation systems, expertise in gas turbine technology & syngas use in gas turbines.
- **Process Systems Enterprises Ltd:**
 - Advanced process modelling software development.
- **C-TECH Innovation Ltd:**
 - Technology development and new products and innovation management.



This Project: Novel low energy plasma/catalytic gas cleaning process to deliver high quality syngas from the gasification of waste biomass

1.3 Evaluation of synthetic natural gas

Objectives

To support Sustainable Research Day (SRD) potential across a range of feedstocks for AD, providing data on SME, emissions and economic impact.

Background

Producing SNG from biomass could be a very effective way of decarbonising the heating sector. This project tests a whole systems approach to evaluating the potential of SNG production from a range of feedstocks.

Downloads

1.3 final.pdf

Partners

- University of Bath
- University of Manchester
- Aston University
- University of Leeds
- Brunel University
- Nottingham Research
- International Energy Ltd

Contact

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Diagram: A flowchart showing the process from feedstocks (waste, agricultural, forestry) to thermochemical production (SNG) and anaerobic digestion (Biogas). It includes a 'Cross-comparison of the thermochemical and biological routes' and a list of project goals: Evaluation of SNG potential in a whole system context, Greenhouse gas balances, Emissions impacts and constraints, Economic viability, and Policy implications.

1.6 Gasification integration

Objectives

To improve the integration of gasification systems with downstream applications such as conversion to electricity or upgrading to biofuels.

Downloads

1.6 final.pdf

Partners

- Nottingham University
- Aston University
- University of Leeds
- Brunel University
- Nottingham Research
- International Energy Ltd

Contact

Professor Adam Harvey
Professor of Process Intensification
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Diagram: A flowchart showing the integration of gasification systems with downstream applications. It includes a 'Workshop with key project partners to share knowledge on gas conditioning and gasification integration' and a 'Viable gasification process concepts scoped & key uncertainties identified'. The diagram also shows 'Upgrading to biofuels' and 'Conversion to electricity'.

2.1 Clean Energy Utilisation from Biogas and Biomass Gasification

EPSC SUPERGEN Bioenergy Challenge Project EP/W016750/1

Objectives

This project aims to develop realistic and predictive physicochemical models for biogas and bio-syngas combustion and mappings between the combustion and emission characteristics and the fuel compositions for clean energy utilisation from renewable gaseous fuels.

Background

The project will provide a better understanding of the complex physicochemical processes of bioenergy utilisation, which can advance bioenergy technology towards deployment.

Method

Based on rigorous modelling and experimentation, the project will deliver a thorough understanding of the utilisation of biogas and bio-syngas, highlighting the effects of variable composition.

Partners

- University of Lancaster (Lead), University of Sheffield, E.ON New Build and Technology Ltd, Silemco plc.

Contact

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Figure: Three vertical heatmaps showing the temperature profiles of syngas combustion, with labels for 'T(K)' and 'Distance (cm)'.

Whole systems approach for syngas production.

Investigates the interface between the gasifier and the associated downstream application.

Predictive syngas combustion and emissions models .

This project: Widens the technical scope by opening up the syngas utilisation options to more higher efficiency gas engines and gas turbines

This project: Development of a new gas cleaning system would form part of the scoping engineering design going forward.

This project: Provides data on high quality syngas composition for modelling .

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