SUPERGEN Bioenergy Hub

Annual Assembly 2014

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

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Introduction

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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

Background

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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

The Project

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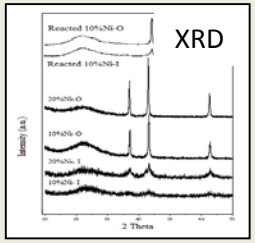
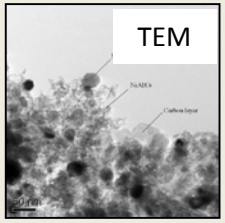
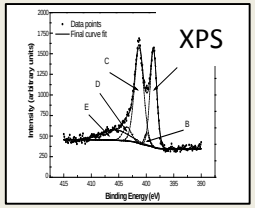
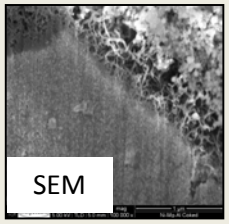
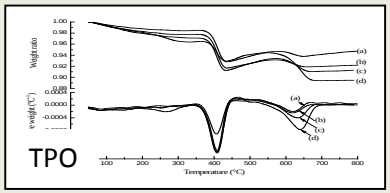
Catalyst Development





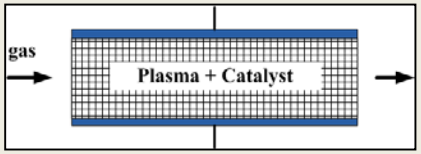


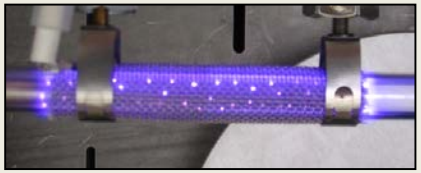


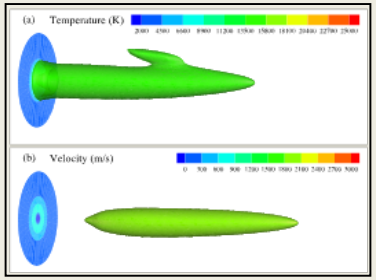


Plasma-Catalysis of model compounds

- Experimental
- CFD modelling

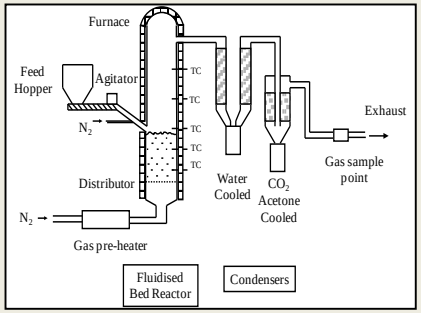


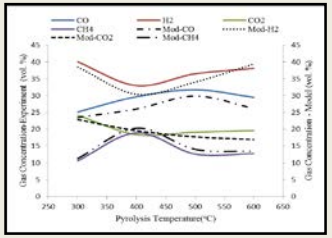


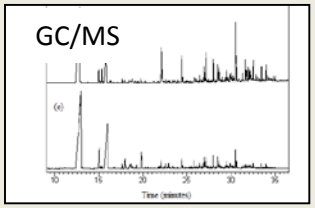


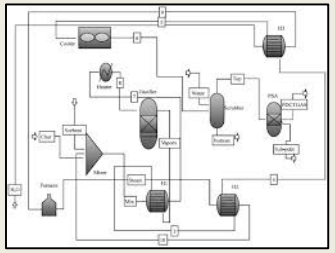
Fluidised bed gasification - catalytic plasma tar reduction

- Experimental
- Process modelling & simulation









University Partners

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- 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

Industrial Partners

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- 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.

SUPERGEN Bioenergy Hub: Links

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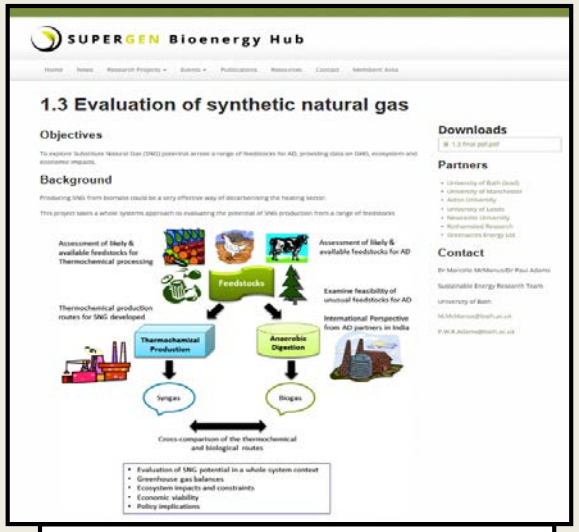
<u>This Project</u>: Novel low energy plasma/catalytic gas cleaning process to deliver high quality syngas from the gasification of waste biomass

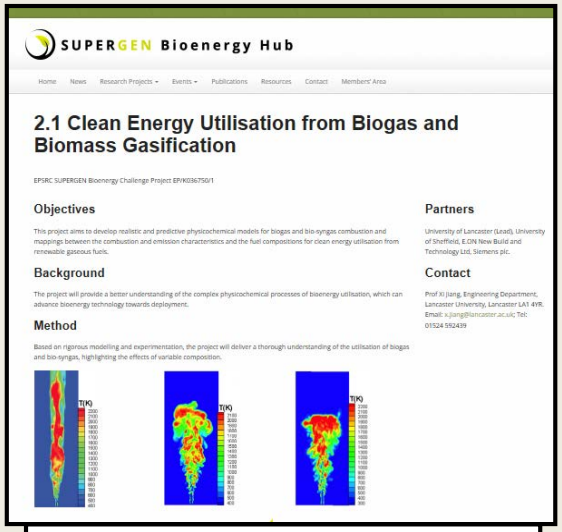


Whole systems approach for syngas production.

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

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

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



Predictive syngas combustion and emissions models .

<u>This project:</u> Provides data on high quality syngas composition for modelling .

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