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EBRI – Aston University

Gasification for Negative Emissions

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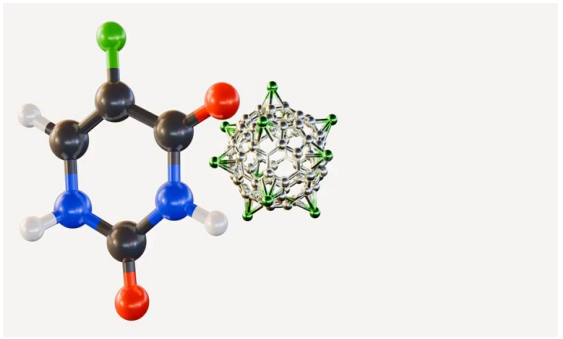
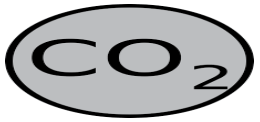
Gasification

Operated at variable conditions



Our TARGET



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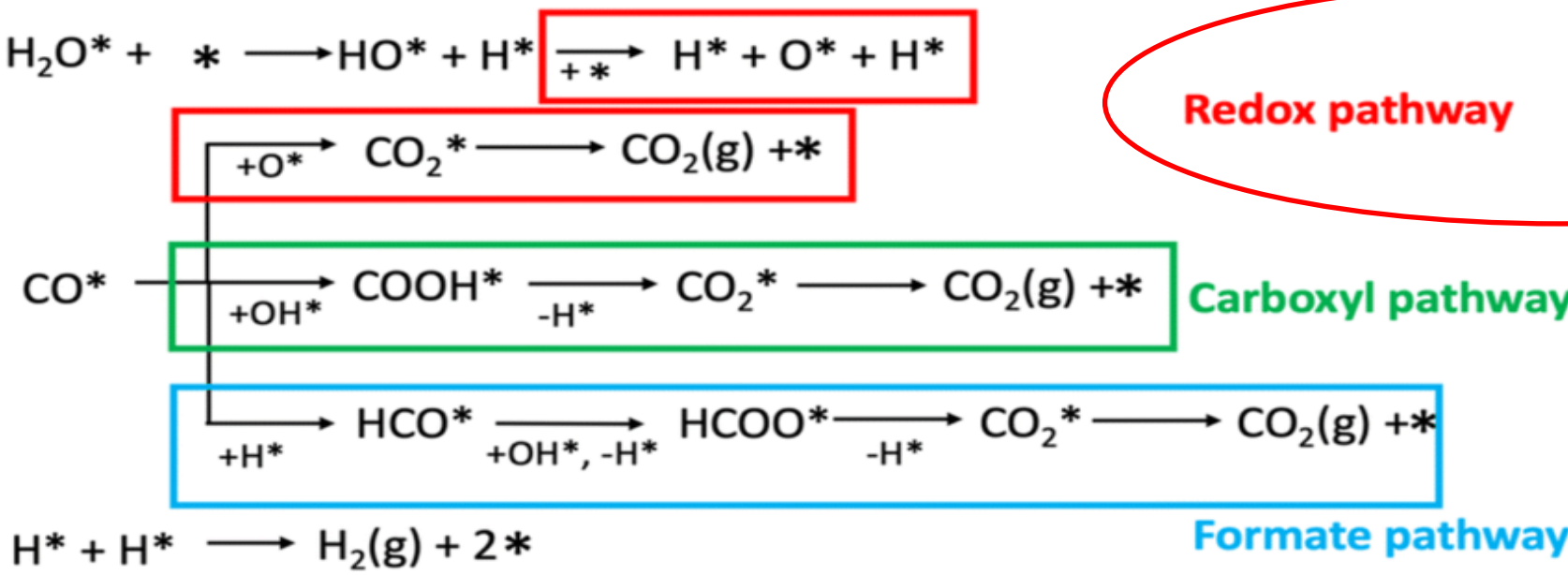
Water-Gas Shift Reaction (WGSR)

$$CO + H_2O \longleftrightarrow CO_2 + H_2$$

Elementary Steps:



Redox pathway Temperatures (>350°C)

Carboxyl pathway Temperatures (<350°C)

Formate pathway Temperatures (<350°C)

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Redox Pathway Chemistry

- CO reacts with an oxygen atom on a catalyst surface (O*) to form CO_2, leaving behind a vacancy (⊡)
- $CO + O^{*} \rightarrow CO_2 + \boxdot$

- Steam fills the vacancy, dissociating into hydroxyl (OH*) and hydrogen (H*) species.
- $H_2O + \boxdot \rightarrow OH^{*} + H^{*}$

- OH* and H* recombine to form H_2, regenerating the oxygen site on the catalyst
- $OH^{*} + H^{*} \rightarrow H_2 + O*$

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Demonstration System

- A 200g/h bubbling fluidised bed gasifier
- Pressurised up to 6~10bar
- Temperatures of 450°C – 650°C
- Inlet gases are N_2 , steam, air, CO, and O_2
- Feedstocks – woody biomass, MSW, RDF, bioplastics, liquid effluents

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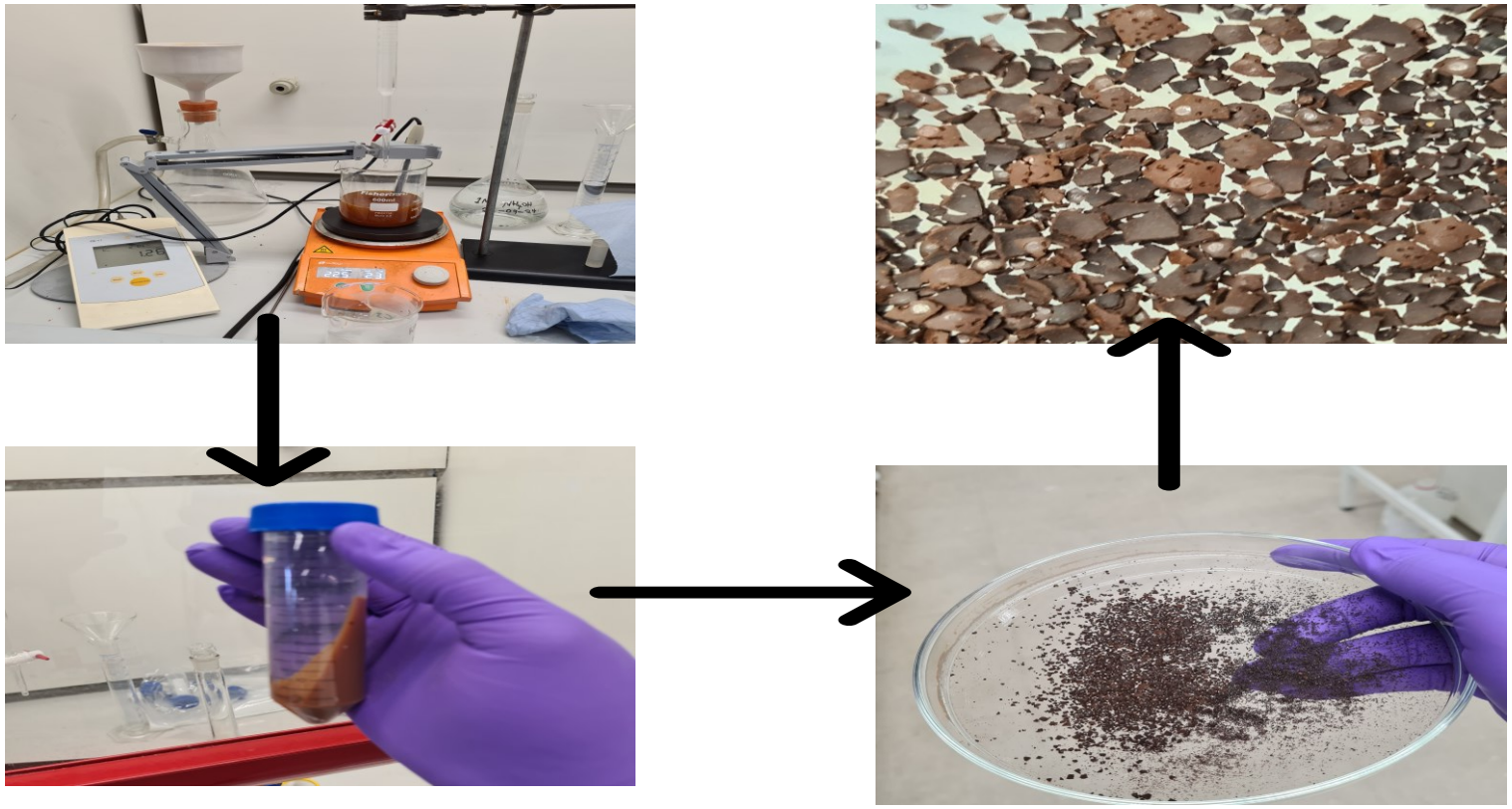
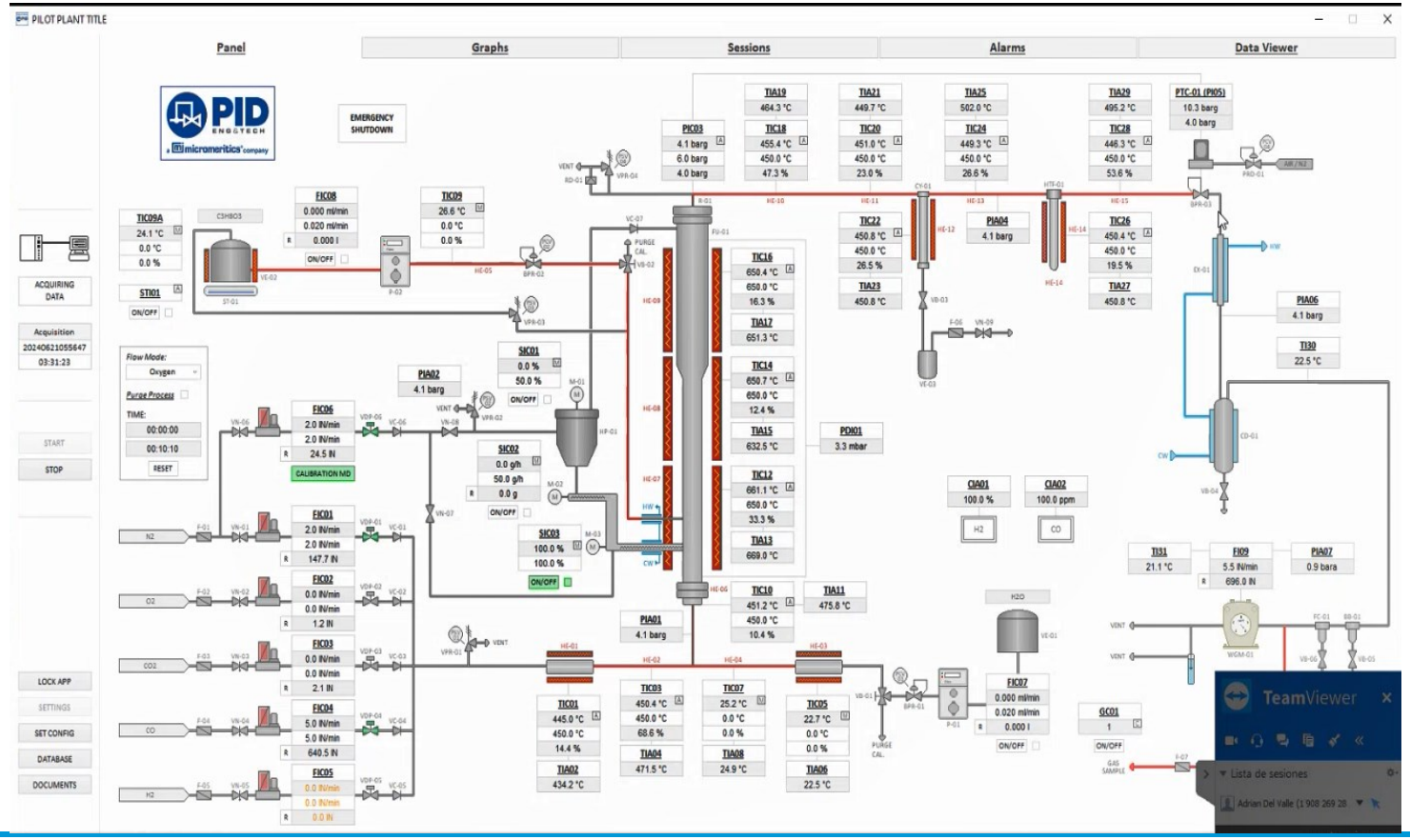
Catalysts Preparation



- Novel catalysts have been synthesised
- Characterisation of these catalysts are ongoing
- Ex-situ and in-situ testing of these catalysts in gasification process are ongoing

Process design, modelling and optimization



- Design the experiment using RSM – CCDs and Box Behnken
- Run experiments, analyse syngas and generate real-time data
- Develop a CFD model of BFB gasifier
- Develop a Simulink model of BFB gasifier
- Input experimental data for models' validation
- Compare model results with experiments and optimise operating conditions
- Use model results to guide experiments

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Engagement with Industry Partners

Industry collaboration on biomass feedstocks: Received willow pellets from industry partners for experimental analysis and awaiting additional samples from the Biomass Connect innovation trials.

Partnership-driven gasification research: Operating a pressurised advanced gasification plant in collaboration with industry, producing hydrogen-rich syngas for real-world applications.

Cutting-edge Digital Twin integration: Collaborating with industry to integrate experimental data and CFD modelling into Digital Twin Technology for enhanced process monitoring and optimisation.

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Get in touch

Internal and external collaborators are fundamental

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THANK YOU

Q&A