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Pilot Campaign Results of Direct Air Capture System: Investigating System Stability at Kilogram-Per-Day Scale

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ABSTRACT

Write your abstract of 400 words

Direct Air Capture (DAC) technology has the potential to limit or reverse the effects of global warming through offsetting carbon dioxide (CO2) emissions and/or removing existing emissions from the atmosphere. DAC systems operate to remove CO2 through standard air processing procedures, by separating atmospheric air into a CO2 lean stream and an enriched CO2 product stream. The CO2 stream can then be utilised as a fossil fuel free source of carbon or stored permanently to form an atmospheric carbon removal process.

The separation can be performed through various processes. This study explores the use of temperature vacuum swing adsorption (TVSA) with a solid, beaded adsorbent to capture CO2 at pilot (kg per day) scale.

After two years of commissioning and system refinement, the pilot plant now operates consistently to capture approximately 420 g of CO2 per seven-hour single-bed cycle. This study presents the first comprehensive test campaign, which included 80 cycles over three test sets investigating the effect of atmospheric conditions on adsorption efficiency and production rate. The test sets were performed over four months in Melbourne, during which there was significant variation in inlet air conditions. The test sets varied adsorption step times to provide an understanding for future adsorption optimisation based on cycle times or cycle parameters.

The test campaign revealed the importance of consistent CO2 adsorption on the cyclic stability of the system. The cyclic adsorption is controlled by the adsorption step time and the air flow rate. The CO2 loading amount varies significantly due to the uncontrolled air temperature and moisture content, which varied daily during the campaign. The adsorption in turn affects the productivity, efficiency and energy use of the pilot plant.

This campaign has significantly improved the understanding of the mechanical, process and chemical stability of the pilot plant and provides valuable insights required for the future continuous operation of larger scale DAC processes.

KEY WORDS

Direct Air Capture, Carbon Capture, Pilot Plant, Carbon Dioxide Removal

BIOGRAPHY

Include a short biographical (100 words) for the presenting author

Maksis Darzins is a post-graduate engineer with a passion for mechanical design and real-world problem solving.

He has a desire to use his skills to create a positive social and environmental impact. He graduated from Monash University with a double degree in Mechanical Engineer and Industrial Design which provided him the skills to continue into the Industry Doctorate Program. His post-graduate work is within a research group investigating Direct Air Capture of Carbon Dioxide at pilot scale.

Maksis believes that climate change can and will be mitigated through innovation, starting at pilot scale within research institutes around the world.

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