Chemical Engineering Thesis Defense

Generalized Process Model for Solid Sorbent Direct Air Capture Contactors

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Abstract

Global emissions of carbon dioxide are reaching new heights every year since the Industrial Revolution. A major contributor to this is fossil fuel consumption. The consumption trend has indicated all this. It has also strengthened the argument for the need to cut down emissions and sweep out historical emissions through the implementation of Carbon Capture, Utilization, and Storage (CCUS) and Carbon Dioxide Removal (CDR) technologies respectively. This is required to control global warming. Direct Air Capture (DAC) is one of the CDR technologies. Extensive research and projections have suggested that DAC has tremendous potential to achieve global climate change mitigation goals. The feasibility of DAC is proven but work is required to bridge gaps in DAC research to make it affordable and scalable. Process modelling is an approach used to address this concern. Current DAC research in system design and modelling is discrete and existing models have limited use cases. This work is focused on the development of a generalized process mass transfer model for the capture stage of solid sorbent DAC contactors. It provides flexibility for defining contactor geometry, selection of ambient conditions, and versatility to plug different sorbents in it for CO2 capture. The modelling procedure is explained, and a robustness check is performed to ensure model integrity. The results of the robustness check and sensitivity analysis are then explained. This research is part of a long-term effort to create a complete modelling package for the DAC community to boost research and development to large-scale deployments.

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