Contribution ID: **1038** Type: **Poster Presentation**

C1Po1D-06 [29]: Numerical study on cryogenic carbon capture by desublimation

Monday, July 22, 2019 9:00 AM (2 hours)

Carbon dioxide (CO2) is the main contributor to greenhouse gases (GHG). Cryogenic carbon capture is a potential alternative for systems with higher CO2 concentration. These methods do not involve the use of any chemicals (like solvents, adsorbents etc.) or supports (like membrane), so that the costs of raw materials and/or their regeneration are done away with. Desublimation is one of the cryogenic carbon capture methods involving the conversion of gaseous CO2 to solid CO2 /dry ice by cooling the feed gas mixture. Before the desublimation of CO2 , all the condensable components (like water, particulate matter etc.) are removed. The primary unit of a desublimation-based carbon capture system is the desublimator that should ensure not only efficient cooling of the CO2 -laden gas but also effective removal of desublimated CO2 (solid) from the system. Nitrogen vapor, liquid nitrogen, liquid methane, hydrocarbon based refrigerant blend etc. are some possible coolants. A few numerical studies on the desublimation-based carbon capture have been reported in the literature. However, all the studies are based on feed gas with low CO2 concentration (up to 20 mol%) and carried out at lab scale only. In this work, a one dimensional numerical model of carbon capture process is developed for better understanding of CO2 desublimation process, with feed gas with higher CO2 concentration (>20 mol%). The model contains a tube-in-tube parallel-flow heat exchanger in which the CO2 -laden feed gas and the coolant are passed through the inner-and outer-tube of the heat exchanger respectively. The presented model shows the effects of the various process variables such as temperature, velocity etc. on the efficacy of carbon capture by desublimation. A parametric study is carried out to know the significance of each process variables.

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Session Classification: C1Po1D - Cryogen Technology