Mathematical Modeling of CO2 Enrichment, Capture and Utilization in Commercial Greenhouses

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Abstract:

This paper investigates carbon dioxide enrichment in commercial greenhouses to improve CO2 capture and utilization. The paper develops and numerically solves a mathematical model that simulates the CO2 capturing process through the coupled non steady- energy and mass species (CO2, H2O) balance equations in the greenhouse components. The model accurately treats the solar radiation transport inside greenhouse. The realistic photosynthesis sub model selected in the present work is a mechanistic one applicable to the commonly planted C3 species. The present model allows strategies for CO2 enrichment and for cooling air inside sealed and ventilated greenhouses. These strategies keep both CO2 concentration and air temperature inside the greenhouse at the required prescribed value within small specified deviation. The validity and accuracy of the present mathematical model were verified through the agreement of its numerical results with the available experimental data in the literature. Numerical predictions of the present model was obtained for a case study to investigate the effects of environmental conditions, CO2 concentration enrichment level, and the cooling method on the cumulative amount of captured CO2 in the greenhouse that describe its performance.

Keywords:

Carbon Capture and Utilization, CO2 enrichment, Greenhouses, Mathematical Model, Bio-fixation, Photosynthesis

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