MODELLING AND SIMULATION OF INTENSIFIED REGENERATOR FOR POST-COMBUSTION CO₂ CAPTURE

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Abstract:

Environmental concern has posed a lot of question as to the impact of greenhouse gas to those changes currently noticed in world climate and the future dangers that will be expected if mitigation measures are not put in place. Carbon dioxide emission from power sector has been the major contributor to the greenhouse gas and capture of CO₂ from such sources is necessary. Post-combustion capture technology is believed to be the most matured and near to commercialization, but it has some challenges such as the size of the absorber and regenerator which are quite big as reported by Lawal et al. (2012). Process intensification (PI) using rotating packed bed (RPB) is the technology that has the potential to reduce the size of a column by order of magnitude without compromising the performance of the columns.

This work models and simulates intensified regenerator using RPB. Four different correlations which are suitable for RPB regenerator were implemented in Aspen Plus rate-based model to replace the default correlations. These correlations are written in visual FORTRAN and then dynamically linked with Aspen Plus rate-based model. The model now represents intensified regenerator. The four new correlations are for liquid and gas mass transfer coefficient, liquid hold-up and interfacial area. Pressure drop correlation suitable for RPB was also included. Heat transfer correlation given by Chilton and Colburn analogy was used since it is function of binary mass transfer coefficient. This invariably means that heat transfer has been intensified.

The model developed was validated based on the experiment data presented in Jassim et al. (2007) which shows good agreement to the experimental data. Process analyses were done to look at the effect of rotor speed on the regeneration efficiency and regeneration energy. The rotor speed was varied from 400 rpm to 1400 rpm, this was selected to cover the validation range of rotor speed. Impact of reboiler temperature on the rate of CO₂ stripping was also studied. Effect of rich-MEA flow rate on regenerator energy and regeneration efficiency was studied, which shows an increase in regeneration energy and a decrease in regeneration efficiency as the rich-MEA flow rate increases.

Keywords: Post-combustion, CO₂ capture, MEA solvent, Process Intensification (PI), Rotating Packed Bed (RPB), Process simulation, Intensified regenerator

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