Process for CO_2 Removal and Valorisation from Cement Flue Gas

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Abstract

Removal of CO_2 from cement flue gas is essential to reduce CO_2 emissions and tackle global warming. In traditional approaches CO_2 is removed, purified and stored, prior to use in a chemical process, and consequently these steps increase the process. In this project, the goal is to remove CO_2 directly by transforming it into a useful (valuable) liquid product via a catalytic reaction employing the flue gas. In the previous phase of the project a fixed-bed flow reactor was designed and constructed. Using this reactor, further optimization of the catalyst was performed and a very stable and inexpensive metal-free catalytic system was identified, that comprises a homogenous catalyst (tetrabutylammonium iodide, TBAI) combined with a heterogenous catalyst (SiO_2). Together these catalysts promote the reaction of styrene oxide and CO_2 to generate styrene carbonate, thus removing the CO_2 from flue gas. Styrene oxide is a valuable bulk commodity chemical and the process can be easily adapted to other oxide starting materials allowing a wide range of different products to be made. In the current process, the styrene oxide is dissolved in a solvent together with the homogenous catalyst, TBAI. The liquid and the gas containing CO_2 are mixed together as they flow through the fix-bed reactor packed with SiO_2 (the heterogenous catalyst). After one cycle, SO reacts with CO_2 to produce styrene carbonate in high yield. Experimental data and modelling has allowed a complete process to be designed. The CO_2 gas stream used in the process must be dried prior to entering the reactor as water was found to deactivate the catalyst.