CP 3

CONCEPT PAPER

for KIER International Cooperation project

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Title	Enabling carbon-based CO_2 adsorbents capable of reducing the thermal regeneration energy in post-combustion capture at operational flue gas temperatures			
Description	Barrier(s) to tackle Post-combustion CO_2 capture (PCC) has been developed over several decades, but to apply the capture technology to real power plants, the energy penalty needs to be small enough so as not to markedly increase the cost of electricity. Typically, the thermal regeneration energy of amine scrubbing, a wet-based capture process, has been reported to be roughly between 2.0 and 4.0 GJ/tCO_2. To make capture economically more attractive for power plant for CCUS application, activated carbons offer many advantages, such as their low regeneration energies and fast adsorption kinetics with little susceptibility to thermo-oxidative degradations, compared to amine-based adsorbents. However, due to the nature of physical adsorption, all carbon materials reported so far need flue gas cooled to < 30 ^{o}C in order to achieve these benefits, which has proved to be a major barrier for their development for PCC. . Strategy to solve Typically, adsorption has lower thermal regeneration energy than absorption. However, there are many obstacles to achieving this because of low dynamic sorption capacity, water co-adsorption and high desorption temperatures. If the dynamic sorption capacity is above 6.0 wt.%, the amount of water adsorption and the temperature difference between adsorption and desorption are low enough, then the thermal regeneration energy can be reduced significantly. The research will involve: • Achieving enhanced equilibrium and dynamic capture capacities (> 9.0 and 6.0 wt.%, respectively) of carbons at realistic flue gas temperatures of ≥ 40 ^{o}C by potassium intercalation from suitable precursors with granules or pellets suitable for use in moving beds. • Maximizing potassium intercalation in carbon materials during preparation. • Preparing large quantities (> 5 kg) of potassium-intercalated activated carbons with high surface areas and pore volumes. • Reducing moisture uptake capacity (< 3.0 wt.%) and kinetics by surface hydrophobization treatments. • Considering PVSA in conjunction with thermal regeneration to reduce the desorption temperatures.			
Outcomes*	Activated carbon granules or pellets having approximately 0.5 mm diameter with sufficient attrition resistance for process operation. Thermal regeneration energy: approaching 1.0 GJ/tCO_2 Dynamic sorption capacity: > 6.0 wt.% with adsorption being conducted at 40 ^{o}C or higher. The amount of water co-adsorption: below 3.0 wt.% over timescales of 10-20 minutes. The temperature difference between adsorption and desorption: ≤ 60°C. Publications and/or Patents: At least one journal or one patent/year.			