Adsorptive Filtration of Carbon Dioxide from Wet Gases Utilizing Microfibrous Filter Media Entrapped K_2CO_3

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Introduction

Present commercial CO_2 removal units utilize a physical solvent of alkanolamine, such as monoethanolamine (MEA), diethanolamine (DEA), and methyldiethanolamine (MDEA). These technologies require large units and high regeneration energy requirement, while exhibiting solvent and equipment degradation. Thus, the development of a new material for a cost-effective filtration with high CO_2 adsorption capacity is needed.

In this paper, a microfibrous entrapped sorbent is developed for CO_2 removal from flue gas. A microfibrous carrier consisting of 4 and 8 μm (dia.) metal fibers is utilized to entrap 150-250 μm (dia.) activated carbon particulates (ACP). K_2CO_3 is then loaded onto the support by pseudo-incipient wetness at various loadings by varying the solution concentration. The adsorption capacity of CO_2 at various K_2CO_3 loadings was investigated as shown in Figure 1. The nano-dispersed nature of K_2CO_3 combined with the use of small support particulates promotes high K_2CO_3 utilization, high contacting efficiency, and high accessibility of K_2CO_3. At equivalent bed volumes, K_2CO_3/ACP entrapped materials provide longer breakthrough times for CO_2 removal compared to packed beds of K_2CO_3 pellets.

At 87% relative humidity, maximum capacity at room temperature based on total weight of adsorbents is found to be around 0.037 g CO_2 with optimal loading of 30 wt.% K_2CO_3 for packed beds corresponding to 33% utilization of impregnated K_2CO_3 as shown in Figure 2. With equivalent K_2CO_3 loading, microfibrous entrapped CO_2 sorbents show an improvement in breakthrough capacity and pressure drop. The use of microfibrous entrapped sorbents provides reduced external mass transfer resistance, enhanced adsorption rates, and lower amounts of heat required for regeneration. This novel adsorbent allows reduction in overall system weight and volume for continuous removal of trace CO_2 from gas streams with high levels of relative humidity, namely a fuel processor stream.

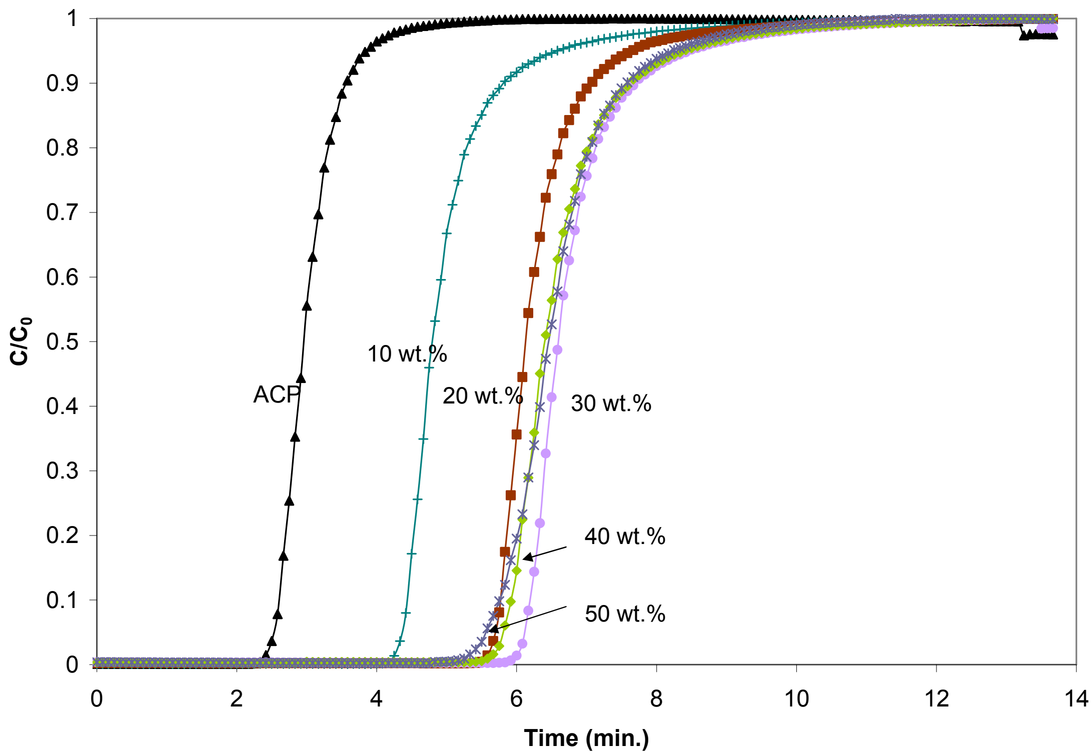

Figure 1: Effect of K_2CO_3 loading on CO_2 adsorption performance studies of ACP supported K_2CO_3. Data were derived from using 1.5% CO2 in He.

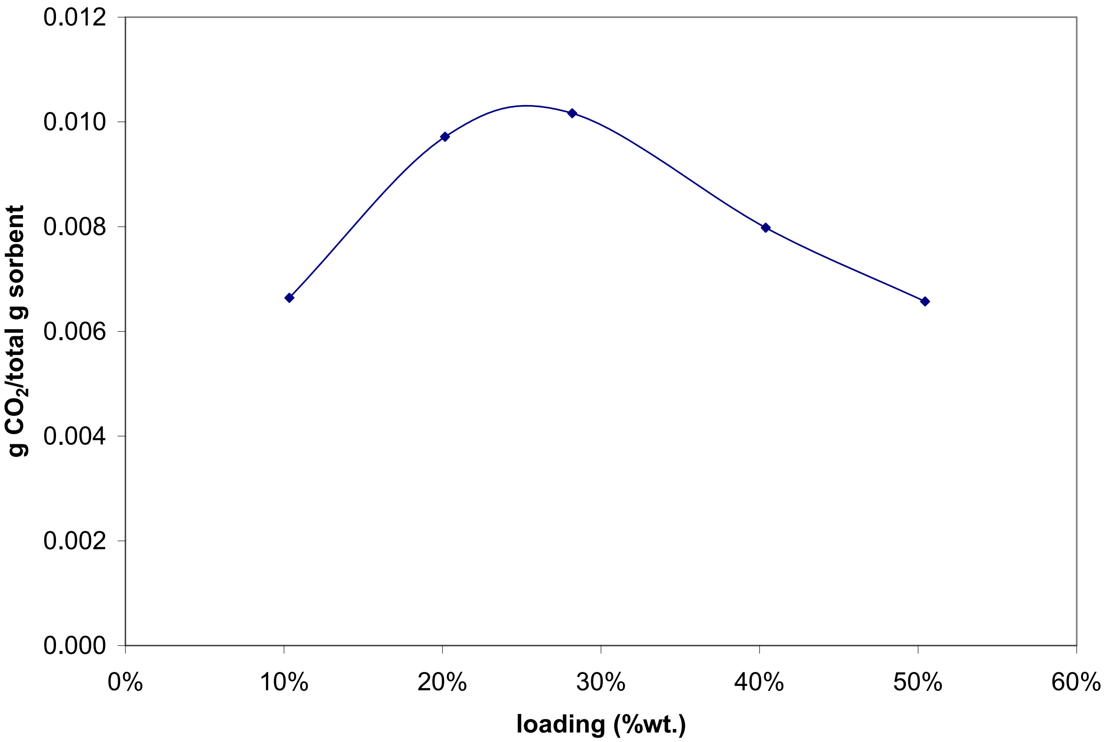

Figure 2: Relationship between adsorption capacity of CO_2 and K_2CO_3 loading