Adsorption
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CO_2 capture by Mg–Al and Zn–Al hydrotalcite-like compounds

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Abstract Hydrotalcite-like compounds (HTC) are distinguished by their properties for CO_2 capture, like high surface area, basic sites, thermal stability and good adsorption/desorption efficiency. Mg–Al e Zn–Al HTCs with Al^{3+} molar ratios x = 0.20, 0.28 and 0.33 were synthesized by coprecipitation, and subsequently calcined at 400 °C. For both HTCs, X-ray diffraction patterns have attested the formation of mixed oxides through calcination. The amount of basic sites, measured by temperature-programmed desorption of CO_2, decreases as x increases. The CO_2 adsorption was performed in a thermogravimetric balance using an adsorption temperature of 50 °C. Mg–Al and Zn–Al samples with x = 0.33 molar composition presented the highest CO_2 adsorption, 0.91 and 0.21 mmol g^{-1}, respectively. The Langmuir isotherm fitted well to the experimental data. It was also found that increasing the number of adsorption/desorption cycles the CO_2 adsorption decreases, which is associated with the irreversible chemisorption.

Keywords Hydrotalcite-like compounds · Basic sites · Adsorption · Carbon dioxide

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1 Introduction

Human activities are increasingly consuming the world resources and the concern about environmental degradation is more and more part of our society. The growing emission of greenhouse gases is worrying because of the major environmental hazards associated with these emissions. There are many gases causing the greenhouse effect, and carbon dioxide is the main among them. Since the time of the industrial revolution, the atmospheric CO_2 concentration has risen by about 35 % to a value of 400 ppm, and is expected to reach 550 ppm by 2050 even if CO_2 emission is stable for the next four decades (IEA Statistics 2014). Consequently, the planet temperature is rising, causing several environmental impacts. Thus, technologies must be developed in order to prevent or reduce CO_2 emissions.

There are three main approaches for CO_2 separation and capture: membrane purification, liquid absorption and adsorption using solids. Membranes are more promising for concentrated CO_2 streams at elevated pressures (Choi et al. 2009). Amines are the most commonly used liquid absorbent for CO_2 capture and it is a well-established commercial technology (Choi et al. 2009; D'Alessandro et al. 2010). Unlike liquid absorbents, solid adsorbents can be used over a wider temperature range from ambient temperature to 700 °C, yield less waste during cycling, and the spent solids can be disposed of without undue environmental precautions (Wang et al. 2011). Moreover, solid adsorbents exhibit better energy efficiency in the regeneration stage compared with absorption approaches and better chemical stability in presence of hydrogen sulfide and steam (D'Alessandro et al. 2010). The adsorbent must have high CO_2 selectivity and adsorption capacity, fast adsorption/desorption kinetics, stable adsorption capacity after repeated adsorption/desorption cycles, and adequate

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