A large decrease in CO\textsubscript{2} emissions through capturing and separation will be required to keep greenhouse gases at tolerable levels (1). Though several CO\textsubscript{2} capture technologies have been proposed, temperature swing adsorption (TSA), consisting in adsorbing the CO\textsubscript{2} on a solid material and, then, inducing the sorbent regeneration and CO\textsubscript{2} recovery by a temperature increase and gas purge, has the potential to become one of the leading techniques by complementing or replacing the current absorption technology due to its low energy requirement (2). With reference to the sorbent, great attention is focused on fine powders (3). Indeed, sorbent in the form of fine powders can be the substrate to realize new highly specific materials whose properties can be tuned at a molecular level and, besides that, most of the commercial adsorbent materials are generally available in the form of fine powders (3). In this respect, sound assisted fluidization is considered to be one of the best technological alternatives to handle and process large amounts of fine powders (4). Moreover, it has already been proved to promote and remarkably enhance the CO\textsubscript{2} capture on fine sorbents, due to large gas-solid contact efficiency, high rate of mass/heat transfer and low pressure drops (5,6). This work is focused on the CO\textsubscript{2} desorption process by TSA in a sound-assisted fluidized bed (40mm ID) of fine activated carbon (Sauter mean diameter = 0.39mm). In particular, desorption tests have been performed under ordinary and sound assisted fluidization conditions (140dB - 80Hz) in order to assess the capability of the sound in promoting and enhancing the desorption process efficiency in terms of CO\textsubscript{2} recovery and purity and desorption time (t\textsubscript{d}). The results obtained show that the application of the sound results in higher desorption rates, CO\textsubscript{2} recovery and purity. Very regular and stable desorption profiles can be obtained under sound assisted fluidization conditions (Fig. 1). This stability makes it possible to successfully realize a cyclic adsorption/desorption process. Then, the effect of desorption temperature (T\textsubscript{des}) (25 - 150°C) and N\textsubscript{2} purge flowrate (45.2 – 90.4NI h\textsuperscript{-1}) on the regeneration efficiency has also been assessed (Fig. 2a and b). An increase of both of them positively affect the desorption process in terms of enhanced desorption kinetics. Increasing temperatures also yield higher CO\textsubscript{2} purities, whereas, no remarkable dilution effect has been observed when increasing the N\textsubscript{2} flow rate. Finally, the activated carbon keeps its performances over 16 adsorption/desorption cycles, in terms of amount of CO\textsubscript{2} adsorbed (n\textsubscript{ads}), breakthrough time (t\textsubscript{b}) and fraction of bed used at t\textsubscript{b} (W), due to the stability of the regeneration process under sound-assisted fluidization conditions (Fig. 3c).
Fig. 1. CO₂ desorption profiles under ordinary (a) and sound assisted (b) conditions; CO₂ recovery (c) as function of desorption time. Adsorption: inlet flow rate = 67.8 Nl h⁻¹; C₀ = 10% vol.; T = 25°C. Desorption: T_{des} = 70°C; N₂ purge flow rate = 67.8 Nl h⁻¹; heating rate = 20°C min⁻¹.

Fig. 2. Effect of temperature (a) and N₂ purge flow rate (b) on CO₂ desorption profiles; CO₂ adsorption performances vs the number of cycles (c). SPL = 140 dB; sound frequency = 80 Hz. Adsorption: inlet flow rate = 67.8 Nl h⁻¹; C₀ = 10% vol; T = 25°C. Desorption: N₂ purge flow rate = 67.8 Nl h⁻¹.

REFERENCES