ADVANCED MANUFACTURING OF ZEOLITE MONOLITHS FOR ENVIRONMENTALLY RELEVANT ADSORPTION PROCESSES

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Zeolite monoliths are widely used in environmental applications due to their outstanding gas-to-solid heat- and mass-transfer characteristics and high specific geometric surface areas, good mechanical properties and very low pressure drops[1] Among the different technologies for manufacturing monoliths, 3D-printing represents one of the most promising approaches in recent years. In particular, 3D-printing is showing itself to be an effective solution for producing geopolymer monoliths.[2] One of the most interesting features of geopolymers is the possibility of promoting zeolite crystallization inside their matrix.[3] In this work, zeolite monoliths were manufactured by 3D-printing geopolymer slurries that subsequently crystallized into a zeolitic phase.

Among the environmentally relevant adsorption processes, CO_2 and water vapor adsorption are two of the most important. Indeed, CO_2 adsorption is crucial for every carbon capture and storage (CCS) technology, whereas water vapor adsorption underlies most of thermal energy storage applications.[4]

In this work, CO_2 and water vapor adsorption on the aforementioned 3D-printed 4A zeolite-rich monoliths coming from geopolymer conversion (3D-ZPMs) has been studied using a gravimetric apparatus based on a McBain-type balance. The balance was set up to run adsorption isotherms at four different temperatures (*i.e.*, 25, 45, 65 and 85 °C). The so-obtained adsorption data have been compared with those concerning commercial powders of the same zeolitic phase contained in 3D-ZPMs.

As regards water vapor, the equilibrium adsorption capacity at atmospheric pressure of 3D-ZPMs is only slightly lower than that of the commercial reference powder (e.g., 8.6 vs 12.4 mol/kg at 25° C). Such gap is more evident for CO_2, *i.e.*, 1.7 vs 2.8 mol/kg at 25° C. In both cases, the performance difference is probably due to the incomplete conversion of the 3D-printed geopolymer into a zeolitic phase.

References

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