GEOPOLYMERS ADSORBENTS: PRODUCTION AND USE

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Key Words: geopolymers, pollutants removal, adsorption, zeolite nucleation, ammonium recovery

Recently, geopolymers are increasingly studied as alternative, cost-effective, eco-sustainable adsorbents for the removal of pollutants from liquid or gaseous systems. They are versatile materials suitable as adsorbents thank to several properties.
Although geopolymers are often compared to zeolites, especially with regard to their synthesis and final properties, in the field of adsorption they can be more performing, offering some advantages.
As zeolites, geopolymers have ionic exchange and electrostatic interaction properties deriving from their 3-dimensional structure, because of the presence of aluminium in tetrahedral coordination.
Modifying the initial composition (Si/Al molar ratio, type of alkaline solution and process conditions), it is possible to synthesize geopolymers with different structures and final properties. Moreover, different types of zeolites can be nucleated starting from optimized geopolymer formulations.
Compared to natural zeolites, geopolymers are more performant in ions exchange applications, because of the tetrahedral coordination of Al^{3+}, compared to the octahedral coordination occurring in natural zeolites. Although geopolymers are amorphous due to the short-range ordering of their network, Al is in tetrahedral coordination in eight-membered or larger aluminosilicate rings as in synthetic zeolites [1]. Geopolymers still need to be studied in order to reach the properties of synthetic zeolites, but have some advantages as a simpler and less energy-intensive synthesis.
Geopolymers have good mechanical properties, can be easily shaped and they are reproducible even on a large scale. Indeed, self-supporting and easy-to-handle porous materials can be produced.
They are intrinsically mesoporous but employing several techniques their porosity can be designed from the micro to the macro scale. Different production processes can be used to mold geopolymers in different shapes as monoliths, granules or beads in order to facilitate the handling and storage and for easiness of operation.
Furthermore, geopolymer matrices can be functionalized with fillers in order to create more performing composite materials able to broaden the range of applications. The possibility of shaping geopolymers and composites in various desired forms opens perspective for better performance in both adsorption and desorption steps [2].
For all the mentioned reasons, different geopolymer matrices and composites have been produced as adsorbents.
Geopolymer-zeolite composites were synthesized, adding zeolites as filler or directly nucleating zeolite from the matrix. In this way, the functional microporosity of the zeolite was combined with the mesoporosity of the geopolymer matrix, allowing to effectively consolidate zeolite, an important aspect at industrial level [3].
Geopolymers and composites were then characterized as adsorbents for the removal of CO_2 or for the treatment of wastewater, in particular for ammonium recovery with a fractioned desorption step able to obtain a product potentially usable as fertilizer [4].

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