Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29455

Ways of modifying the sorption properties of natural zeolites and zeolites synthesised from fly ash

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Zeolites are used in many industry areas, engineering, and environmental protection. Zeolites are particularly useful for the adsorptive removal of inorganic and organic pollutants. In our study, we used different zeolites to demonstrate their suitability for removing pharmaceuticals, volatile organic compounds, pesticides, hydrocarbons, radioactive isotopes, metals and metalloids. We investigated the sorption capacities of raw and modified clinoptilolite and zeolites synthesised from fly ash: zeolite P1, X, A and zeolite-carbon composites.

The best sorption efficiency of cationic forms of metals were found for unmodified synthetic zeolites. An explanation for the superiority of synthetic zeolites over natural zeolites is the higher cation exchange capacity (CEC) and surface area (BET) values of synthetic zeolites compared to natural zeolites. Sorption of Cr(VI), As(V), V(V), Mo(VI), and W(VI) would not be possible without prior modification of the zeolite. The modified synthetic zeolites removed more significant amounts of anionic forms of metals and metalloids from the solution than the modified natural zeolites. It was also shown that modification of the synthetic zeolites with aminopropyl imidazole (ionic liquid), followed by Fe_3O_4 nanoparticles and combination with polymeric materials (polystyrene sulphonate (PSS), polyvinyl alcohol (PVA) and chitosan), allowed the formation of a magnetic thin film (Fe_3O_4 NPs@zeolite film) that shows excellent functionality and durability for the sorption efficiency.

In a study of ^{238}U removal efficiency, we investigated the sorption capacity of the zeolite P1 using sodium alginate (SA). The higher sorption capacity of the SA-functionalised zeolite was confirmed by CEC values of 468 and 596 meq/100 g for P1 beads with 0.5%wt. and 1%wt. SA, compared to powdered zeolite P1 - 263 meq/100g. The study demonstrated successful and effective synthetic zeolite modification with a biodegradable polymer (SA).

Experiments on the regeneration and reuse of sorbents indicate that they can be reused many times without significantly deteriorating their sorption capacity. Sorbents can be used in dusty or granular form. Functionalised zeolites and zeolite-organic materials synthesised from fly ash can be used as sorbents for water and wastewater treatment.

Acknowledgment

Research Project partly supported by program “Excellence initiative – research university” for the AGH University of Krakow.