Alginate based composites as an alternative for recovery of critical raw materials – rare earth elements

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Rare Earth Elements (REEs) are a group of elements that includes the lanthanides as well as scandium and yttrium. The REEs are of great interest, which is constantly growing, due to a number of desirable properties. Their properties are exploited in numerous modern technologies, i.e. high temperature superconductors, next generation rechargeable batteries, compact fluorescent lamps, automotive catalytic converters, and others [1]. It is commonly accepted that REEs consumption is a measure of a country's level of industrial development and technological progress. Due to the difficult situation on the REEs market, caused by the tightening of their export amounts by China and the growing demand for them, it is becoming increasingly important to search for their alternative sources. One solution is to recycle waste products, mainly electronic devices, and separate REEs from wastes. Conventional processes for the REEs recovery include coagulation, flotation, chemical precipitation, flocculation, electrochemical processes, ion exchange, and adsorption [2,3].

In the last decades the study and development of new adsorbents were intensive. In the present study the novel alginate based composites were fabricated by external gelation using calcium chloride as a crosslinking agent. The new biosorbents were characterized by the ATR/FT-IR and XPS spectroscopy, SEM-EDX microscopy, AFM, XRD, BET, TG as well as the sieve analysis. Moreover, the points of zero charge of composites were determined by the drift method. In the next step alginate based composites abilities as biosorbents for the rare earth elements recovery from aqueous solutions were studied. Four elements, i.e. La(III), Ce(III), Pr(III), and Nd(III), were selected for sorption studies. Sorption experiments were performed using the batch-adsorption techniques, investigating the effects of pH solution, mass sorbent, contact time, initial metal concentration, and temperature. The research allowed to determine the kinetic, equilibrium, and thermodynamic parameters of the sorption process. In order to investigate the biosorbents reusability the sorption-desorption cycles were performed 6 times. The obtained sorption results show the applicability of the alginate-based biosorbents for the rare earth elements recovery.

References

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