

Sorption of Pb^{2+} and Zn^{2+} ions on Zr-Ca-Mg phosphates: Kinetics and mechanism studies

Natalja Kitikova^a, Andrei Ivanets^a  , Irina Shashkova^a, Ludmila Kulbitskaya^a,
Omirserik Baigenzhenov^b, Mika Sillanpää^{c d e f}

Show more 

 Add to Mendeley  Share  Cite

<https://doi.org/10.1016/j.jwpe.2023.103725>

[Get rights and content](#) 

Highlights

- The kinetic adsorption of Pb^{2+} and Zn^{2+} ions from model solutions was studied.
- The high efficiency of Zr-Ca-Mg composite phosphates as adsorbents was shown.
- The maximum adsorption capacity of Pb^{2+} and Zn^{2+} ions reached 4.76 and 4.13 mmol/g.
- Intraparticle diffusion had a significant effect on Zn^{2+} ions adsorption.
- The dissolution–precipitation and ion exchange adsorption mechanism was proposed.



Access through your organization

[Purchase PDF](#)

Abstract

The kinetics study of Pb^{2+} and Zn^{2+} ions adsorption by low-cost mixed Zr-Ca-Mg phosphates with a different Zr/(Ca+Mg) ratio was carried out, for the first time. The effect of chemical composition on adsorption characteristics of obtained adsorbents was established. It was shown that an increase of Ca^{2+} and Mg^{2+} cations content in the composition of Zr-Ca-Mg phosphate adsorbents contributed to an increase in the adsorption capacity to Pb^{2+} (3.82–4.76 mmol/g) and Zn^{2+} (2.60–4.13 mmol/g) ions. Such improvements in the adsorption capacities were due to the amelioration of the textural properties of adsorbents, so that A_{BET} of adsorbents was in the range of 68–96 m²/g and $V_{\text{des BJH}}$ of adsorbent was in the range of 0.19–0.24 cm³/g. On the other hand, increase of Ca^{2+} and Mg^{2+} cations led to a high difference in solubility products of initial phosphates and spent adsorbents. Kinetic data of Pb^{2+} and Zn^{2+} ions adsorption revealed that the adsorption rate is controlled by film diffusion, intraparticle diffusion and chemical interaction, which was confirmed by the results of X-ray diffraction analysis of spent adsorbents and described by the pseudo-second-order model. The increase of zirconium content caused an increase in the rate constant of the pseudo-second-order of Pb^{2+} and Zn^{2+} ions adsorption. Intraparticle diffusion had a significant effect on Zn^{2+} ions adsorption. Due to the suitable kinetics parameters and sorption capacities of composite Zr-Ca-Mg phosphates for divalent metal ions, these sorbents can be recommended as effective materials for heavy metals removal.