



Studies on ion exchange behavior of cesium into zirconium molybdopyrophosphate and its application as precursor of cesium ion sieve

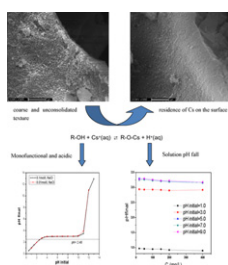
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HIGHLIGHTS

- ▶ Preparations of zirconium molybdopyrophosphate by orthogonal synthetic experiments.
- ▶ Surface characterization of the material.
- ▶ Investigation of cesium exchange behavior into the material.

GRAPHICAL ABSTRACT



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ABSTRACT

A new inorganic ion exchanger, zirconium molybdopyrophosphate, was synthesized by both precipitation and hydrothermal reactions. Through orthogonal experiments the sample obtaining the highest cesium exchange capacity was chosen and characterized by X-ray diffraction, scanning electron microscope, specific surface area along with determination of pH at the point of zero charge. Batch experiments were carried out to evaluate the effects of operational parameters such as initial pH, exchanger dose, contact time and Cs^+ concentration on the cesium exchange capacity of the optimum sample. Evolution of solution pH presented in each case evidenced the main $\text{Cs}^+ - \text{H}^+$ ion exchange mechanism. The pH at the point of zero charge indicated this ion exchanger as monofunctional and acidic in character. The ion exchange process followed the Langmuir and pseudo-second-order model. The results showed that the optimum sample with a considerable capacity of 1.21 mmol/g might be a suitable precursor for cesium ion-sieve.

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1. Introduction

There have been numerous literatures published in recent years focusing on synthetic inorganic ion exchangers in the form of powder, granule, membrane and fiber for diverse applications including analysis, preconcentration, ionic species recovery [1–4], among

which ion exchangers for treatment of nuclear effluents are the most extensively studied [5]. Furthermore, the removal of ^{137}Cs considered as a key radionuclide of high activity and long half-life has been a hot topic for scientists interested in designing effective ion exchanger simultaneously demonstrating large cesium exchange capacity (CEC) and selectivity towards cesium in the complex waste solutions.

Natural and synthetic zeolites, hydrous oxides, insoluble hexacyanoferrate, crystalline silicotitanates (CST), acidic salts of multivalent metals, polyoxometalates and composite ion exchangers are used to remove ^{137}Cs in solutions with different salt content and acidity [6–10]. The inorganic ion exchangers or adsorbents with specific selectivity for an ion species can be called ion-sieve [11]. Cesium ion-sieve exhibits high selectivity towards Cs^+ with

Abbreviations: ZMPP, zirconium molybdopyrophosphate; CEC, cesium exchange capacity; pH_{pzc} , pH at the point of zero charge; CST, crystalline silicotitanates; HLLW, High Level Liquid Waste; OE3, sample no. 3 by orthogonal experiment denoted as L16 (4, 5) ZMPP; HT, hydrothermal product.

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