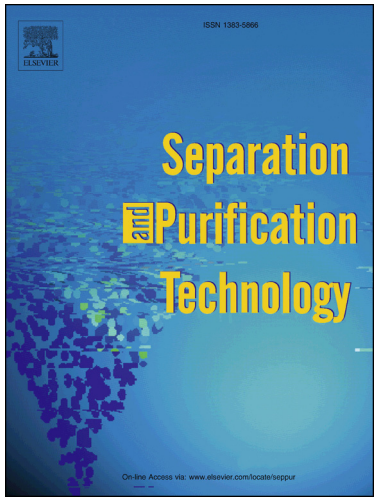

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PII: S1383-5866(16)32805-2
DOI: http://dx.doi.org/10.1016/j.seppur.2017.03.019
Reference: SEPPUR 13605

To appear in: *Separation and Purification Technology*

Received Date: 22 December 2016
Revised Date: 11 March 2017
Accepted Date: 13 March 2017

Please cite this article as: Y. Wu, X. Xia Zhang, Y-Z. Wei, H. Mimura, Development of adsorption and solidification process for decontamination of Cs-contaminated radioactive water in Fukushima through silica-based AMP hybrid adsorbent, *Separation and Purification Technology* (2017), doi: http://dx.doi.org/10.1016/j.seppur.2017.03.019

Development of adsorption and solidification process for decontamination of Cs-contaminated radioactive water in Fukushima through silica-based AMP hybrid adsorbent

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Abstract

Developing highly efficient cesium (Cs) adsorbent and a stable solidification method for Cs is vital for the advancement of the decontamination system for Fukushima Daiichi Nuclear Power Plant. A novel porous silica loaded with ammonium molybdophosphate (AMP/SiO_2) was prepared through impregnation/precipitation/freeze-drying method. The composite with 32.4 wt% AMP loading amount had superior large 254.2 Å pore width and 72.2 m^2/g surface area. The ^{137}Cs removal efficiency in actual seawater was 97.1% within 30 min, indicating that AMP/SiO_2 effectively treated contaminant water with low-level concentration of Cs even in the presence of highly concentrated competing ions. The AMP/SiO_2 adsorption of ^{137}Cs in seawater conformed well with Redlich-Peterson model. The ion exchange ratio of Cs^+ and NH_4^+ in AMP was estimated to be 71% from the equivalent of Cs_2NH_4MP. Pyrogenetic AMP/SiO_2-adsorbed Cs (Cs-AMP/SiO_2) was decomposed above 400 °C sintering temperature, and Cs immobilization (%) decreased from 100% to 40% after sintering at 1,200 °C; porous silica support matrix had no immobility for Cs. In contrast, adding natural mordenite (NM) can depress the volatilization of Cs, resulting to the steady immobilization ratio of Cs at nearly 100% for the sintered products. The crystal phase immobilizing Cs was identified as $Cs_4Al_4Si_{20}O_{48}$ through X-ray diffractometry. The Cs leachability from the sintered products was less than 0.1% even at 90 °C in distilled water and 0.1 M sodium chloride.

Keywords:

^{137}Cs, AMP, mordenite, decontamination, secondary solid wastes, solidification