Rapid Removal of Cesium from Fukushima Contaminated Soil by Hydrothermal Treatment with Multivalent Cations

*Xiangbiao Yin [1], Yoshikazu Koma [1], Yusuke Inaba[2], Kenji Takeshita [2]

[1] Collaborative Laboratories for Advanced Decommissioning Science, Japan Atomic Energy Agency

[2] Laboratory for Advanced Nuclear Energy, Tokyo Institute of Technology

Abstract: The decontamination and volume reduction of Cs contaminated soil remains a great challenge after the Fukushima Daiichi Nuclear Power Plant accident. In present study, the authors aim to develop the continuous hydrothermal treatment process to remove Cs rapidly from the clay soils by a column system. The results will inspire new insights for treatment of post-accident soils in Fukushima.

Keywords: Cesium desorption, hydrothermal treatment, volume reduction, ion exchange, decontamination

1. Introduction

After the Fukushima accident, radioactive Cs was widely dispersed and contaminated the north-eastern district of Japan, thus the topsoil has been stripped within the top 5 cm which is now just being stored in temporary storage sites because of its difficulty of decontamination.[1-2] Therefore, it is urgently essential to develop environmental friendly and efficient techniques performing desorption of Cs^+ ions from the clay soils.

2. Experiment and results

Vermiculitized biotite (VB) powder (10 g) was dispersed in CsCl solution (1L) with Cs^+ concentration of 1000 mg L^{-1} for 3 months, reaching a saturated Cs adsorption capacity of 41.32 mg-Cs/g-VB. Subsequently, 0.5g of as-prepared Cs-VB was loaded into a stainless steel column reactor and flowed with the 0.01M $MgCl_2$ in rate of 0.5 mL/min at room temperature and/or subcritical condition (250°C, 4MPa). The Cs concentration in the effluent was measured with the time. Figure 1 shows the diagram of the column system with continuous hydrothermal treatment.

Figure 2 shows the continuous Cs desorption by the column system at different treating temperatures. It reveals that the adsorbed Cs can only be slowly and limitedly extracted by Mg^{2+} at 25°C, with a desorption ratio lower than 20% in sum. By contrast, the Cs desorption kinetics is improved significantly under the subcritical conditions, achieving 100% summed desorption ratio in less volume of Mg^{2+} solution. These results clearly suggested the hydrothermal treatment of the clay soils in the column system could achieve rapid and continuous Cs desorption, which was expected to establish more practical technologies for treatment of the Cs-contaminated soils.

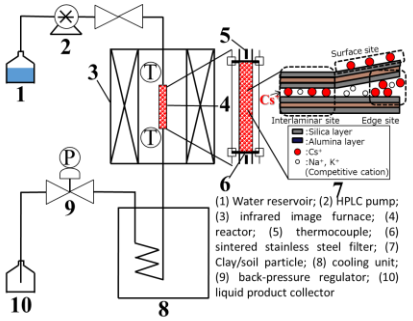

Fig. 1 Schematic diagram of continuous column system.

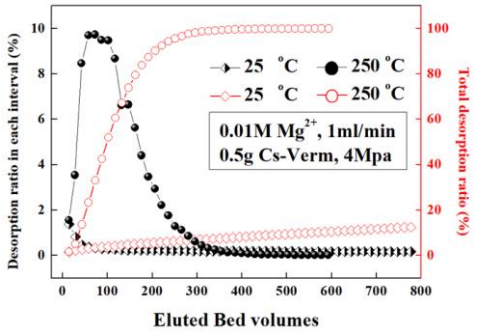

Fig. 2 Continuous Cs desorption from Cs saturated clay.

References

[1] Yin X., Wang X., Wu H., Ohnuki T., Takeshita K., *Journal of hazardous materials*, **326**, 47-53 (2017).

[2] Yin X., Inaba Y., ... & Takeshita, K., *Chemical Engineering Journal*, **333**, 392-401 (2018).