

# Desorption of Cesium From Montmorillonite and Hydrobiotite by Cationic Detergent

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## 1. Introduction

Cesium desorption on soil have been of important issue after the severe environmental contamination of Fukushima area in Japan with radionuclides. Soils are composed of sand, silt and clay, and radionuclides are selectively adsorbed to clay in soil. Upon release of radioactive cesium from the nuclear facility, the dissolved cesium ions in waster can be transferred to the clay component in soil. Cesium is generally adsorbed in the interlayer of clay minerals, and irreversible adsorption takes places at the frayed edge site (FES), which is highly stable and hardly removable by conventional soil treatment methods.

Among the clay minerals, montmorillonite, which is a 2: 1 phyllosilicate clay mineral, is well known to adsorb cesium with the highest adsorption capacity, and cesium ions are generally adsorbed on clay interlayer. Hydrobiotite is an interstratified clay of vermiculite and biotite. Vermiculitic clay contains more cesium-specific adsorption sites than illitic clay and the amount of FES can increase as weathering of micaceous minerals.

In this study, we investigated the behavior of Cs desorption from montmorillonite and hydrobiotite by a cationic surfactant and a cationic polyelectrolyte. In order to remove cesium contaminated with montmorillonite, tetramethylammonium bromide (TMAB), Octyltrimethylammonium bromide (OTAB), Dodecyltrimethylammonium bromide (DTAB), Cetyltrimethylammonium bromide (CTAB) was selected as the cationic surfactant. In hydrobiotite, DTAB and polyethyleneimine (PEI) was selected as a cationic polyelectrolyte. To compare the Cs desorption efficiency, the adsorption and Cs desorption from montmorillonite and hydrobioite were analyzed.

## 2. Experimental

Montmorillonite and hydrobiotite were dispersed in an aqueous CsCl solution, and the mixtures were subjected to a horizontal shaker for one week at 20 °C. The Cs-adsorbed clay was collected by centrifugation at 7000 rpm followed by drying at 40 °C. The concentration of Cs in the solution was measured with inductively coupled plasma mass spectrometry.

Cs-MMT was mixed with TMAB, OTAB, DTAB and CTAB solution, and Cs-HBT was mixed with DTAB and PEI solution in deionized water. The clay was separated and washed twice with deionized water by centrifugation and was dried at 40 °C. The desorbed amount of Cs was analyzed by measuring the Cs concentration in the aqueous phase by inductively coupled plasma mass spectrometry.

## 3. Result & discussion

The Cs adsorption behaviors of MMT and HBT in CsCl solutions were observed at 20 °C. Both montmorillonite and hydrobiotite showed that Cs adsorption isotherm data fit well to the Langmuir Model ( $R^2 = 0.999$ ), and the maximum Cs adsorption capacity was 0.684 mmol/g and 0.184 mmol/g based on the fitting analysis, respectively (Fig. 1).

Both montmorillonite and hydrobiotite showed increased Cs desorption as the concentration of desorption agent increased. The cationic surfactant showed efficient desorption of cesium ion by ion-exchange with trimethyl ammonium head group of surfactant on montmorillonite. PEI showed the highest Cs desorption efficiency by ion exchangers with high cationic charge of the polyelectrolyte originating from its large number of ionizable units on hydrobiotite (Fig. 2).

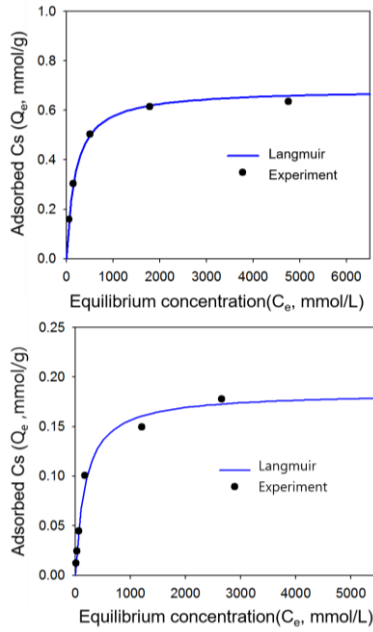


Fig. 1. Cs adsorption isotherm of montmorillonite and hydrobiotite at 20°C. The line indicates the result of fitting with the Langmuir adsorption model.

#### 4. CONCLUSIONS

We investigated adsorption of Cs ions on montmorillonite and hydrobiotite, and Cs desorption by ion exchange with cationic molecules including a cationic surfactant, cationic polyelectrolyte and ammonium ion. The maximum Cs desorption efficiency achieved was 99% on montmorillonite and 79% on hydrobiotite, respectively. This is because cesium ions in the interlayers were replaced by desorption agent by ion-exchange. This comparative Cs desorption study proved that polyelectrolyte-based desorption methods will have great potential for remediation of Cs-contaminated soil.

#### REFERENCES

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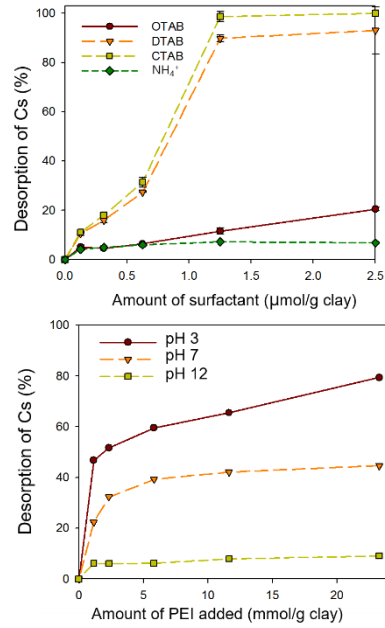


Fig. 2. Cs desorption after reaction of Cs-MMT and Cs-HBT with various amounts of desorption agent at 20°C.