Study on the characterization and performance of removing cesium by geomaterials

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1. Introduction

With the development of modern science and technology, nuclear energy has been widely applied in industry, national defense, agriculture, medicine and scientific research, which inevitably produces radioactive waste liquid. In particular, a large number of radioactive materials were leaked and a large number of wastewater containing radioactive cesium (Cs) was discharged by the Fukushima Dai-ichi nuclear power plant accident in Japan. As these waste liquids are radioactive, they will cause immeasurable harm to the environment and human bodies. Thus, the development of effective method for removing Cs from radioactive waste liquids has been widely concerned by people. In this work, the adsorption by geomaterials is chosen as the method to remove Cs. The geomaterials were prepared as adsorbent by using fly ash and slag as raw materials and activated by alkali activator.

2. Experimental method

The materials were characterized by X-ray diffraction (XRD), Scanning electron microscopy with energy dispersive spectrometer (SEM-EDS), BET surface area, pore volume and pore size analysis. The adsorption experiment of Cs was conducted under different experimental conditions such as pH, contact time and adsorbent dosage. Adsorption isotherms of Cs onto the geomaterials was investigated with varying initial concentrations under optimum experiment conditions. The content of Cs was determined by inductively coupled plasma mass spectrometry (ICP-MS). Kinetic models and adsorption isotherm models are used to describe the mechanism involved in the adsorption process.

3. Results and Discussion

The following were clarified mainly by this study：

(1) By means of XRD, SEM/EDS and BET/BJH, it was found that no cesium-containing crystalline phase was detected in the geopolymer adhesive and that there was no change of crystal structure before and after the adsorption. The distribution of Cs in the binder matrix is uniform throughout the adhesive substrate and negatively correlated with sodium. Moreover, the fly ash-based geomaterials has a higher micropore surface area.

(2) The adsorption isotherm was most adapted to the Langmuir adsorption isotherm (Fig.1), suggesting a strong tendency for the adsorption of monolayers. It was kinetically well fitted to the pseudo-second-order reaction (Fig.2). This can be interpreted as the fixation mechanism of cesium in the fly ash-based geomaterials is controlled by the cation exchange mechanism.

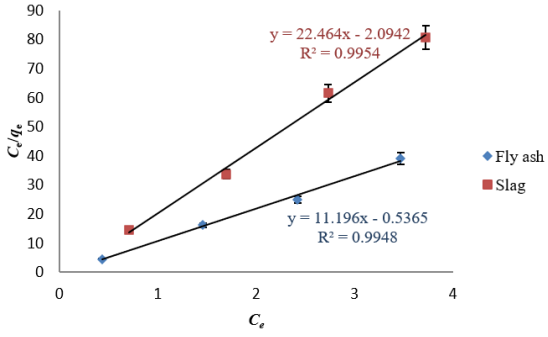

Fig. 1 Langmuir isotherm of Cs adsorption

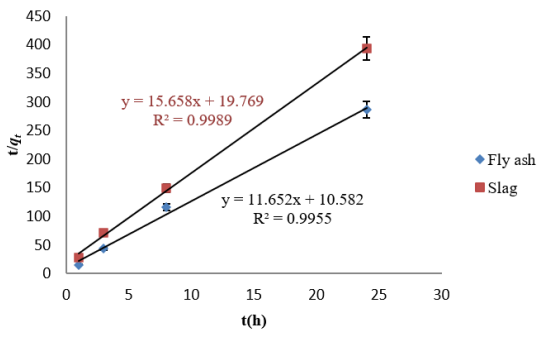

Fig.2 Pseudo-second-order model of Cs adsorption