Magnetic Clay Microspheres Prepared by Spray-Drying for Adsorption of Cs

Chan Woo Park[1*], Gyeong Jun Chung[2], Juri Hwang[1,2], Hee-Man Yang[1], and In-Ho Yoon[1]
[1]Decontamination & Decommissioning Research Division, Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea
[2]Department of Chemical Engineering, Chungnam National University, 99, Daehak-ro, Yuseong-gu, Daejeon, Republic of Korea
[*]chanwoo@kaeri.re.kr

1. Introduction

Natural clay minerals have high cation adsorption properties because they have an anionic layered structure. Since the price of clay is very low, in addition, the clay is widely used as an adsorbent for hazardous materials. Smectite, vermiculite, and illite are general 2:1 type clay minerals, and each clay mineral shows different Cs adsorption properties. Expendable clay minerals, such as smectite and vermiculite, have high adsorption capacity for Cs. Even though illite has a low Cs adsorption capacity, it has a frayed edge site which has high selectivity for Cs ion.

According to the soil classification based on particle size, clay is classified as less than 2 micrometers. In order to remove the radionuclides in the waste water or contaminated ground water by using clay as an adsorbent, a column process is generally utilized. However, because of the small size of the clay, the permeability is low and thus the decontamination rate is low. In order to solve such a disadvantage, small clay particles must be processed to make large particles. It is also preferred that the adsorbent has magnetism so that it can be recovered by the magnet after use for easy recovery of the adsorbent used.

Among the various microparticle preparation methods, the spray drying method easily provides a microsphere. Various morphology and size can be controlled according to manufacturing conditions.

In this study, we prepared microsphere type adsorbent by spray drying clay mineral and magnetic iron oxide nanoparticles. Montmorillonite, vermiculite, and illite were used as clay minerals and poly (vinyl alcohol) was used as a binder. The physicochemical properties of the prepared microparticles were analyzed and the adsorption characteristics of the adsorbents to Cs ions were evaluated.

2. Experimental methods

2.1 Preparation of clay microspheres

Clay mineral and iron oxide (~ 50 nm) were dispersed into an aqueous solution of 3% poly (vinyl alcohol) (PVA) using a homogenizer. The dispersion was pumped into a spray dryer and the dispersion was sprayed at an inlet temperature of 160. The collected microspheres were observed by optical microscope and scanning electron microscope.

3. Results and Discussion

3.1 Preparation of clay microspheres

When the clay microsphere was prepared by spray drying, illite and montmorillonite formed spherical particles, whereas vermiculite did not. Even though the vermiculite used in the experiment was crushed into small particles, irregular shape of the powder

was not suitable for the preparation of microspheres.

Montmorillonite and illite microspheres were formed by aggregation of clay platelets, and pore spaces between clay particles formed porous microstructures. The size of the particles was 10 to 30 micrometers.

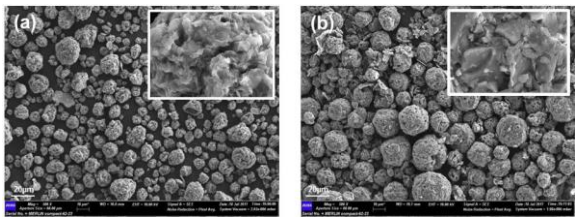

Fig. 1. Scanning electron microscopy images of (a) montmorillonite and (b) illite microspheres.

3.2 Magnetic separation of clay microspheres

In order to recover the adsorbent after adsorption of radionuclides, 50 nm sized iron oxide particles were mixed with clay to prepare microsphere. As shown in the figure, the microparticles dispersed in water can be easily recovered by the external magnet.

Fig. 2. Magnetically collected clay microspheres after adsorption of Cs.

4. Conclusion

Montmorillonite or illite-based clay microsphere for Cs adsorption was prepared by spray drying method. After spray drying, a spherical microspheres with a porous structure were obtained. Clay microspheres containing iron oxide were easily recovered by external magnetic field after adsorption of ions.

REFERENCES

[1] M. J. P. Ribeiro, J. A. Labrinch, “Control of geometrical parameters of clay particles processed by spray-drying with relevance in water filtration beds”, Industrial Ceramics, 18(2), 74-79 (1998).