

## 論文内容の要旨

氏名 LOPEZ GUZMAN  
FRANCISCO JAVIER

Extensive work on geopolymer research has been conducted so far. However, existing literature on the adsorption of heavy metals using geopolymers is very little. Geopolymers could offer an alternative to remove heavy metals from wastewater via adsorption and become a new method for affecting both the environment and societies positively. Therefore, this work focused on a developing field that utilizes cheap and plentiful described geopolymer adsorbents composed of aluminosilicate of metakaolin (MK) which are excellent pozzolanic source materials to geopolymers. **Chapter 1** has presented a brief introduction of different methodologies of removing heavy metals from wastewater and polymers. Here are introduction of concepts of adsorption technology to pollutant and geopolymerization. In **Chapter 2**, the effect of the amorphous silica derived from biomass rice husk (RH) in the alkaline activating solution on the properties was investigated in geopolymerization process, when metakaolin was used as the aluminum source from metakaolin (MK). With changing a molar ratio of  $\text{Si}/\text{Al}_2 = 3.0$  and  $10$ , the curing in the preparation of geopolymers was carried out at  $85^\circ\text{C}$ ,  $100^\circ\text{C}$  and  $200^\circ\text{C}$ . Viscoelastic properties of the geopolymer pastes including  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$  components suggested that the alkaline activation was found in higher RH silica source. The mineralogical and microstructural characteristics of the cured products were evaluated to be amorphous aluminosilicate. **Chapter 3**, Geopolymer adsorbents were prepared from silica and MK in different Al and Si components and the geopolymers were applied for removal of metal ions,  $\text{Cs}^+$  and  $\text{Pb}^{2+}$ , from other heavy metal ions mixture. When geopolymer was optimized at  $\text{Si}/\text{Al} = 2$  as adsorbent, targeting to  $\text{Cs}^+$  and  $\text{Pb}^{2+}$  separation was observed. The binding behavior was well fitted to Langmuir model, which proved that the metakaolin-based geopolymer had multi-binding to adsorb ions. The effective adsorption was also observed independent of NaCl concentration for the  $\text{Cs}^+$  and  $\text{Pb}^{2+}$ . This meant that the ion adsorption of geopolymers occurred under non-electrostatic mechanism. In **Chapter 4**, it is investigated that the geopolymer foam materials could obtained and applied as adsorbents for capture of cesium ions. Geopolymer foams showing cesium adsorption were prepared by condensing a mixture of MK and alkali solution at  $100^\circ\text{C}$  in the presence of RHA powder, and they showed effective adsorption of cesium. In final **Chapter 5**, conclusion of this doctoral thesis is summarized.