Low temperature synthesis of zeolitic and cementitious materials for environmental cleanup

K. Pimraksa[a*], N. Setthaya[b], K. Juengsuwattananon[a]

[a]Department of Industrial Chemistry, Faculty of Science, Chiang Mai University, 50200, Thailand

[b]Division of Chemistry, School of Science, University of Phayao, 5600, Thailand

*E-mail address: Kedsarin.p@cmu.ac.th

Environmental cleanup is highly essential to handle substances such as heavy metals, organic dyes and volatile organic compounds which are environmentally harmful and health hazard. Zeolitic and cementitious materials have been accepted to be one of the key materials to quarantine those contaminants. Low temperature synthesis of zeolitic and cementitious or geopolymeric materials can be carried out using dissolution-precipitation and dissolution-polycondensation, respectively. Starting materials as sources of reactive alumina and silica used for the synthesis of both zeolite and geopolymer could be clay minerals with thermal activation as well as kind of industrial wastes such as combustion by-products (lignite fly ash, bottom ash and rice husk ash). For zeolite synthesis, reactive aluminosilicate starting materials were dissolved by sodium and potassium hydroxide solutions and the dissolved species were precipitated to form various kinds of zeolites mainly dependent on SiO_2/Al_2O_3 and Na_2O/Al_2O_3 molar ratios. The incubation temperature and template type also played a big role to crystallize the required zeolitic materials. For geopolymer synthesis, reactive aluminosilicate starting materials were dissolved by sodium and potassium hydroxide solutions. Additional chemical such a sodium silicate was also used to accelerate polycondensation. Binding properties of the obtained geopolymer was dependent on SiO_2/Al_2O_3, Na_2O/Al_2O_3 and H_2O/Na_2O molar ratios as well as curing temperature and time. To formulate the hybrid materials between zeolite and geopolymer, the SiO_2/Al_2O_3 molar ratio was necessarily kept to be in the range of zeolite and geopolymer requirement.

The mechanism for the hazardous material isolation (heavy metals, organic dye and volatile organic carbon) is mainly via adsorption. Zeolite (Natrolite-K) was more effective in the adsorption of Cr, Ni and Cd than potassium aluminosilicate hydrate and bottom ash powders. When blended with Portland cement, potassium aluminosilicate hydrate performed better than natrolite-K in point of heavy metal encapsulation. In addition, zeolite with the presence of TiO_2 worked better than pure zeolite for removal of methylene blue dye with photocatalytic performance.

KEY WORDS: Zeolite; Geopolymer; Adsorption