World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:05, 2018

Fluoride Immobilization in Plaster Board Waste: A Safety Measure to Prevent Soil and Water Pollution

Authors : Venkataraman Sivasankar, Kiyoshi Omine, Hideaki Sano

Abstract : The leaching of fluoride from Plaster Board Waste (PBW) is quite feasible in soil and water environments. The Ministry of Environment, Japan recommended the standard limit of 0.8 mgL^{-1} or less for fluoride. Although the utilization of PBW as a substitute for cement is rather meritorious, its fluoride leaching behavior deteriorates the quality of soil and water and therefore envisaged as a demerit. In view of this fluoride leaching problem, the present research is focused on immobilizing fluoride in PBW. The immobilization experiments were conducted with four chemical systems operated by DAHP (diammonium hydrogen phosphate) and phosphoric acid carbonization of bamboo mass coupled with certain inorganic reactions using reagents such as calcium hydroxide, sodium hydroxide, and aqueous ammonia. The fluoride immobilization was determined after shaking the reactor contents including the plaster board waste for 24 h at 25˚C. In the DAHP system, the immobilization of fluoride was evident from the leaching of fluoride in the range 0.071-0.12 mgL^{-1}, 0.026-0.14 mgL^{-1} and 0.068-0.12 mgL^{-1} for the reaction temperatures at 30˚C, 50˚C, and 90˚C, respectively, with final pH of 6.8. The other chemical systems designated as PACCa, PACAm, and PACNa could immobilize fluoride in PBW, and the resulting solution was analyzed with the fluoride less than the Japanese environmental standard of 0.8 mgL^{-1}. In the case of PACAm and PACCa systems, the calcium concentration was found undetectable and witnessed the formation of phosphate compounds. The immobilization of fluoride was found inversely proportional to the increase in the volume of leaching solvent and dose of PBW. Characterization studies of PBW and the solid after fluoride immobilization was done using FTIR (Fourier transform infrared spectroscopy), Raman spectroscopy, FE-SEM (Field Emission Scanning Electron Microscopy) with EDAX (Energy Dispersive Spectroscopy), XRD (X-ray diffraction), and XPS (X-ray photoelectron spectroscopy). The results revealed the formation of new calcium phosphate compounds such as apatite, monetite, and hydroxylapatite. The participation of such new compounds in fluoride immobilization seems indispensable through the exchange mechanism of hydroxyl and fluoride groups. Acknowledgment: First author thanks to Japanese Society for the Promotion of Science (JSPS) for the award of the fellowship (ID No. 16544).

Keywords : characterization, fluoride, immobilization, plaster board waste
Conference Title : ICEWRM 2018 : International Conference on Environment and Water Resource Management
Conference Location : Tokyo, Japan
Conference Dates : May 28-29, 2018