World Academy of Science, Engineering and Technology
International Journal of Energy and Environmental Engineering
Vol:18, No:04, 2024

Stabilization of Pb, Cr, Cd, Cu and Zn in Solid Waste and Sludge Pyrolysis by Modified Vermiculite

Authors : Yuxuan Yang, Zhaoping Zhong

Abstract : Municipal solid waste and sludge are important sources of waste energy and their proper disposal is of great importance. Pyrolysis can fully decompose solid wastes and sludge, and the pyrolysis products (charcoal, oil and gas) have important recovery values. Due to the complex composition of solid wastes and sludge, the pyrolysis process at high temperatures is prone to heavy metal emissions, which are harmful to humans and the environment and reduce the safety of pyrolysis products. In this paper, heavy metal emissions during pyrolysis of municipal sewage sludge, paper mill sludge, municipal domestic waste, and aged refuse at 450-650°C were investigated and the emissions and hazards of heavy metals (Pb, Cr, Cd, Cu and Zn) were effectively reduced by adding modified vermiculite as an additive. The vermiculite was modified by intercalation with cetyltrimethylammonium bromide, which resulted in more than twice the original layer spacing of the vermiculite. Afterward, the interpolated vermiculite was made into vermiculite flakes by exfoliation modification. After that, the expansion rate of vermiculite flakes was increased by Mg2+ modification and thermal activation. The expanded vermiculite flakes were acidified to improve the textural characteristics of the vermiculite. The modified vermiculite was analysed by XRD, FT-IR, BET and SEM to clarify the modification effect. The incorporation of modified vermiculite resulted in more than 80% retention of all heavy metals at 450°C. Cr, Cu and Zn were better retained than Pb and Cd. The incorporation of modified vermiculite effectively reduced the risk of heavy metals, and all risks were low for Pb, Cr, Cu and Zn. The toxicity of all heavy metals was greatly reduced by the incorporation of modified vermiculite and the morphology of heavy metals was transformed from Exchangeable and acid-soluble (F1) and Reducible (F2) to Oxidizable (F3) and Residual (F4). In addition, the increase in temperature favored the stabilization of heavy metal forms. This study provides a new insight into the cleaner use of energy and the safe management of solid waste.

Keywords : heavy metal, pyrolysis, vermiculite, solid waste
Conference Title : ICEEESD 2024 : International Conference on Energy, Environment, Ecosystems and Sustainable Development
Conference Location : Tokyo, Japan
Conference Dates : April 22-23, 2024