World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:11, No:01, 2017

Advanced Separation Process of Hazardous Plastics and Metals from End-Of-Life Vehicles Shredder Residue by Nanoparticle Froth Flotation

Authors : Srinivasa Reddy Mallampati, Min Hee Park, Soo Mim Cho, Sung Hyeon Yoon

Abstract : One of the issues of End of Life Vehicles (ELVs) recycling promotion is technology for the appropriate treatment of automotive shredder residue (ASR). Owing to its high heterogeneity and variable composition (plastic (23–41%), rubber/elastomers (9–21%), metals (6–13%), glass (10–20%) and dust (soil/sand) etc.), ASR can be classified as 'hazardous waste', on the basis of the presence of heavy metals (HMs), PCBs, BFRs, mineral oils, etc. Considering their relevant concentrations, these metals and plastics should be properly recovered for recycling purposes before ASR residues are disposed of. Brominated flame retardant additives in ABS/HIPS and PVC may generate dioxins and furans at elevated temperatures. Moreover, these BFRs additives present in plastic materials may leach into the environment during landfilling operations. ASR thermal process removes some of the organic material but concentrates, the heavy metals and POPs present in the ASR residues. In the present study, Fe/Ca/CaO nanoparticle assisted ozone treatment has been found to selectively hydrophilize the surface of ABS/HIPS and PVC plastics, enhancing its wettability and thereby promoting its separation from ASR plastics by means of froth flotation. The water contact angles, of ABS/HIPS and PVC decreased, about 18.7°, 18.3°, and 17.9° in ASR respectively. Under froth flotation conditions at 50 rpm, about 99.5% and 99.5% of HIPS in ASR samples sank, resulting in a purity of 98% and 99%. Furthermore, at 150 rpm a 100% PVC separation in the settled fraction, with 98% of purity in ASR, respectively. Total recovery of non-ABS/HIPS and PVC plastics reached nearly 100% in the floating fraction. This process improved the quality of recycled ASR plastics by removing surface contaminants or impurities. Further, a hybrid ball-milling and with Fe/Ca/CaO nanoparticle froth flotation process was established for the recovery of HMs from ASR. After ball-milling with Fe/Ca/CaO nanoparticle additives, the flotation efficiency increased to about 55 wt% and the HMs recovery were also increased about 90% for the 0.25 mm size fractions of ASR. Coating with Fe/Ca/CaO nanoparticles associated with subsequent microbubble froth flotation allowed the air bubbles to attach firmly on the HMs. SEM–EDS maps showed that the amounts of HMs were significant on the surface of the floating ASR fraction. This result, along with the low HM concentration in the settled fraction, was confirmed by elemental spectra and semi-quantitative SEM–EDS analysis. Developed hybrid preferential hazardous plastics and metals separation process from ASR is a simple, highly efficient, and sustainable procedure.

Keywords : end of life vehicles shredder residue, hazardous plastics, nanoparticle froth flotation, separation process
Conference Title : ICWMRE 2017 : International Conference on Waste Management and Remediation Engineering
Conference Location : Sydney, Australia
Conference Dates : January 26-27, 2017