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High-gravity carbonation process for CO2 fixation and alkaline waste stabilization

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An integrated approach to establishing a waste-to-resource supply chain within an industrial park was developed for CO2 fixation, wastewater neutralization and product utilization using high-gravity carbonation (HiGCarb) process. Several alkaline wastes, such as steel slag and byproduct lime, were gathered for performance evaluation operated under various levels of reaction temperature, rotation speed, and liquid-to-solid (L/S) ratio. A high CO_2 capture efficiency (i.e., >95%) can be achieved via the HiGCarb process with a relatively short reaction time at ambient temperature and pressure. These alkaline wastes were found to be successfully carbonated with CO_2 in the high-gravity carbonation process, where calcite ($CaCO_3$) was identified as the main product. In addition, the results indicated that the rates of metal ion leaching from the alkaline solid wastes can be prohibited by the high-gravity carbonation process. Moreover, blended cements containing 5%, 10% and 20% replacements of ordinary Portland cement with carbonated solid wastes were tested for compressive strength development and autoclave soundness. The mortars were casted into 50 mm×50 mm×50 mm molds, and then tested at 3, 7 and 28 days. Since the carbonated product can be used as supplementary cementitious materials, CO_2 emissions from the cement industry can be avoided if a green waste-to-resource supply chain between the petrochemical and cement industries is established. It suggests that an integrated approach to the proper treatment of alkaline wastes that permanently fixes CO_2 from industries while producing valuable supplementary cementitious materials for the cement industry can be achieved via the HiGCarb process.

Biography

Shu Yuan Pan received his Master's in 2011 and PhD in 2016 in Environmental Engineering from National Taiwan University, mentored by Professor Pen-Chi Chiang. Currently, he is a Research Assistant at Energy Systems Division, Argonne National Laboratory, USA, and serves as an Adjunct Researcher at Carbon Cycle Research Center at National Taiwan University, Taiwan. He was recently elected as one of the Green Talents from BMBF, Germany in 2013 due to his achievement on sustainable development. He has dedicated his research efforts to CO2 fixation and utilization, and water reuse process. Moreover, he has published more than 25 papers in reputed SCI journals.

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