University of Connecticut
Department of Civil and Environmental Engineering
Environmental Engineering Program

Yaguang Du

PHD THESIS DEFENSE
DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING
ENVIRONMENTAL ENGINEERING PROGRAM
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CAST 306

Advisor Committee:
Maria Chrysochoou (Major Advisor)
Amvrossios C. Bagtzoglou (Associate Advisor)
Baikun Li (Associate Advisor)
Timothy Vadas (Associate Advisor)
Liyuan Chai (Associate Advisor)

"An investigation of the geochemical properties and treatment of soda ash Chromite Ore Processing Residue"

Abstract: In recent years, the common lime-based roasting process of chromite ore that is used to extract chromium is being replaced by alternative processes that produce less waste. Chromite Ore Processing Residue (COPR) contains high concentrations of hexavalent chromium (Cr(VI)), a human carcinogen, and is a hazardous waste that requires intensive treatment prior to disposal. China has banned the lime roasting process since 2013 and an alternative process using soda ash as roasting and complexing agent has replaced it in the larger factories. The process still produces COPR with residual Cr(VI), albeit in lower amounts. Although much is known about the properties and treatment of lime-based COPR, there are no studies in the literature on soda ash derived COPR. Accordingly, this research constitutes the first comprehensive assessment of soda ash COPR in terms of: a) chemistry, mineralogy and leaching characteristics; b) speciation of Cr(VI) in the solid; c) treatment of residual Cr(VI) using different reducing agents. The COPR sampled from a large factory in China contained 8,500 mg/kg of Cr(VI), indicating poor recovery during the leaching process. Preliminary tests indicated that approximately 90% of the Cr(VI) is water soluble, while the remaining 10% is more tightly held within the matrix and requires lowering the pH from 12.5 to 8 for release. Accordingly, all studies will be performed on two distinct COPR fractions: "original" COPR, with the material tested as-is, and "column leached" COPR, which has been subjected to DI water leaching to remove all water-soluble Cr(VI) prior to further studies. The proposed research is divided into three parts: The first part is a leaching and modeling study of the two COPR types, studying the leaching of major and trace elements as a function of pH. The second part utilized microstructural spectroscopy techniques (micro-X-ray Fluorescence, Absorption and Diffraction) to study the mineral hosts of Cr(VI), information used to optimize treatment. Finally, the third part evaluated the reduction of residual Cr(VI) in COPR using calcium polysulfide, nano-scale zerovalent iron stabilized with gree tea extract (GT-nZVI), and pyrolysis remediation with miscanthus mixture.