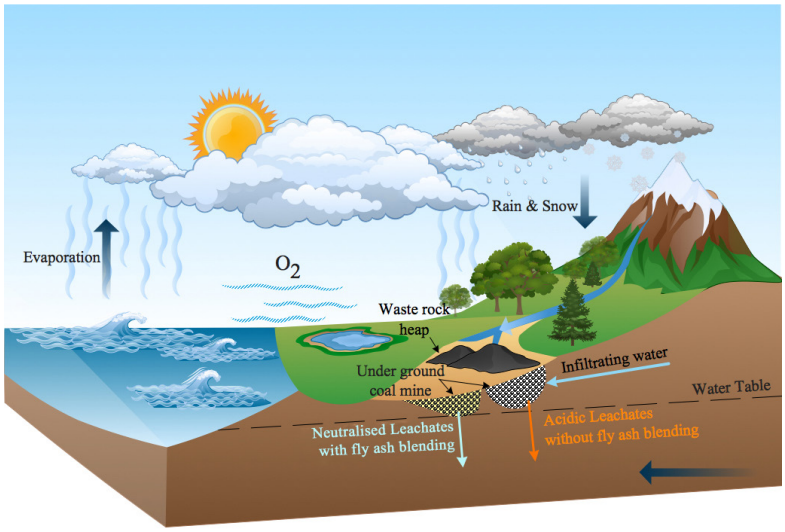
LICENTIATE THESIS

Potential of Fly Ashes for Neutralisation of Acid Mine Drainage from Coal Mine Waste Rock



Asif Qureshi

LULEÅ UNIVERSITY OF TECHNOLOGY

Abstract

Many countries around the world use coal as fuel for the purpose of power generation. The extraction of coal produces large volumes of waste rock (WR) that are sometimes sulphide rich (principally containing iron sulphides such as pyrite (FeS_2) and pyrrhotite ($Fe_{1-x}S$)), with varying quantities of trace elements such as As, Si, Cu, Zn, Ni, Co, Mo and Cr etc). Such waste is environmentally sensitive due to the risk of oxidation in presence of atmospheric oxygen and water. Sulphide oxidation may result in acidic waters (acid mine drainage, AMD), which often contains high loads of dissolved metals. Coal combustion results in large amounts of fly ash (FA), which also is of environmental concern. However, FA is alkaline and may potentially be used for neutralisation of AMD. Therefore, the AMD producing potential of WR from coal mining and the neutralisation potential of FAs from coal and biomass combustion was studied with the ultimate goal to develop a methodology to decrease the environmental problems related to these materials.

WR was sampled form the Lakhra coal field in Pakistan, which has an estimated coal reserve of 1.3 Bton, from lignite to sub-bituminous in quality. The WR samples were characterised by mineralogical and geochemical methods and the acid producing potential was determined by static (Acid Base Accounting) and kinetic (modified humidity cells test) methods. Besides organic material, the WRs are composed of quartz, pyrite, kaolinite, hematite and gypsum with varying amounts of calcite, lime, malladerite, spangolite, franklinite and birnessite. The Lakhra WR has strong potential to generate AMD (-70 to -492 kg $CaCO_3$/ton) and pollute natural waters by leaching of elements such as Cd, Co, Cr, Cu, Ni, Pb, Zn, Fe and SO_4^{2-}.

Three different FAs based on the origin, fuel type and storage methods were studied. They were characterised by mineralogical and geochemical methods, the leachability was studied by batch leaching tests and the potential for buffering acids and neutralisation of AMD was quantified. Fly ash from burning i) brown coal (lignite) in Pakistan (PK), ii) black (bituminous) coal from Finland (FI) and iii) biomass FA provided by a sulphate pulp and paper mill in Sweden (SE) were studied. All ashes contained quarts, PK also iron oxide, anhydrite, and magnesioferrite, FI also mullite and lime, and SE also calcite and anorthite. All ashes were enriched in As, Cd, Co, Cr, Cu, Hg, Ni, Pb and Zn compared to continental crust, and all ashes had a strong neutralisation potential, the bioash (SE) in particular.

The results are encouraging and suggest that it is possible to use FA to mitigate the environmental problems with coal mine WR. Methods for that will be the focus for the continued research.