

Integrated acid mine drainage management using fly ash

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Abstract

Fly Ash (FA) from a power station in South Africa was investigated to neutralise and remove contaminants from Acid Mine Drainage (AMD). After this primary treatment the insoluble FA residue namely solid residue (SR) was investigated as a suitable mine backfill material by means of strength testing. Moreover, SR was used to synthesise zeolite-P using a two-step synthesis procedure. Furthermore, the zeolite-P was investigated to polish process water from the primary FA-AMD reaction. The main objective of this series of investigations is to achieve zero waste and to propose an integrated AMD management using FA. Fly Ash was mixed with AMD at various predetermined FA-AMD ratios until the mixtures achieved circumneutral pH or higher. The supernatants were then analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Ion Chromatography (IC) for cations and anions respectively. The physical strength testing of SR was carried out by mixing it with 3% Ordinary Portland Cement (OPC) and curing for 410 days. Synthesis of zeolite-P using SR was carried out by two step synthesis procedure: ageing for 24 hours followed by a mild hydrothermal synthesis at 100°C for 4 days. The polishing of process water from primary AMD treatment using FA was ascertained by mixing the process water with zeolite at a liquid to solid ratio of 100:1 for 1 hour. The results indicated that FA can be successfully used to ameliorate AMD. High removal of major AMD contaminants Fe, Al, Mg, Mn and sulphate was achieved with the ash treatment and trace elements such as Zn, Ni, Cu and Pb were also removed by the FA. Strength testing over 410 days indicated that the material gained strength over the testing period. The maximum unconfined compressive strength and elastic modulus was observed to be approximately 0.3 MPa and 150 Mpa respectively. The X-ray diffraction (XRD) analysis of the synthesized product indicated that SR was successfully converted into zeolite-P with some mullite phase remaining as a result of incomplete conversion of the feedstock SR. The zeolite-P was used as an ion exchange material to remove selective elements from the process water. Elements such as Ca, Sr, Ba and V were successfully removed from the process water with the zeolite-P. Only marginal removal of Mo was observed during the experiments. It was also observed that Na was exchanged into the solution. This study successfully demonstrated zero waste concepts and an integrated AMD management scheme using FA was developed in this study. The implementation of this technology will address FA storage problem as well as costs associated with AMD treatment.

Keywords

- [Acid mine drainage](#),
- [fly ash](#),
- [neutralization](#),
- [backfilling](#),
- [zeolites](#).