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Laboratory study on the mobility of major species in fly ash–brine co-disposal systems: up-flow percolation test

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Abstract

Apart from the generation of fly ash, brine (hyper-saline wastewater) is also a waste material generated in South African power stations as a result of water re-use. These waste materials contain major species such as Al, Si, Na, K, Ca, Mg, Cl and SO_4. The co-disposal of fly ash and brine has been practiced by some power stations in South Africa with the aim of utilizing the fly ash to capture the salts in brine. The effect of the chemical interaction of the species contained in both fly ash and brine, when co-disposed, on the mobility of species in the fly ash–brine systems is the focus of this study. The up-flow percolation test was employed to determine the mobility of some major species in the fly ash–brine systems. The results of the analysed eluates from the up-flow percolation tests revealed that some species such as Al, Ca and Na were leached from the fly ash into the brine solution while some species such as Mg, Cl and SO_4 were removed to some extent from the brine solution during the interaction with fly ash. The pH of the up-flow percolation systems was observed to play a significant role on the mobility of major species from the fly ash–brine systems. The study showed that some major species such as Mg, Cl and SO_4 could be removed from brine solution using fly ash when certain amount of brine percolates through the ash.

1 Introduction

The combustion of coal for power generation is on the increase due to the increase in demand for electricity globally. Huge amounts of fly ash are produced as a result of the increase in coal combustion. According to US Coal Combustion Product Production & Use Survey Report, US power plants produced about 60 million tons of fly ash in 2011, out of which nearly 39 % was beneficially used (ACAA 2011). South African power utilities generate significant quantities (about 40 Mt) of fly ash annually of which the power stations operated by ESKOM South Africa generate 25 Mt of the fly ash annually (ESKOM Report 2013). Out of the fly ash generate in South Africa per annum, less than 10 % is beneficially utilized. The fact remains that, despite its beneficial use for agricultural purposes, waste stabilization, additive to cement, road construction among others (Iyer and Scott 2001; Kumpiene et al. 2006; Foner et al. 1999), significant amounts of fly ash are being disposed in ash dump. Fly ash contains major and minor species such as Ca, Na, Mg, K, SO_4, Cl, Fe, As, Pb, Cu, Cr, Mo, Mn, etc., and these species could leach out in significant quantities from fly ash when in contact with aqueous solution (Ilic et al. 2003; Baba and Kaya 2004;

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