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Properties of steel foundry electric arc furnace dust solidified/stabilized with Portland cement

Guray Salihoglu*, Vedat Pinarli, Nezih Kamil Salihoglu, Gizem Karaca

Department of Environmental Engineering, Faculty of Engineering-Architecture, Uludag University, 16059, Bursa, Turkey

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Abstract

Electric arc furnace dust from steel production is generated in considerable amounts worldwide and needs to be treated as hazardous waste. The aim of this study was to investigate the properties of electric arc furnace dust solidified/stabilized by using Portland cement. Mortar and paste samples were prepared with varying waste-to-binder ratios between 0% and 90%. A comprehensive experimental program was designed including XRF characterization, setting time, unconfined compressive strength, and toxicity characteristics leaching procedure (TCLP), synthetic precipitation leaching procedure (SPLP), and acid neutralization capacity (ANC) tests. The results were evaluated in order to determine if the solidified /stabilized product can be disposed of at a landfill site with domestic waste or at a segregated landfill. The effect of using sand on S/S performance was also investigated.

The results indicated that the solidification /stabilization process using PC helps the heavy metals to be bound in the cement matrix, but the TCLP leaching results exceeded the EPA landfilling limits. The SPLP leaching results conformed to the limits implying that the waste or S/S products can be disposed of at a segregated landfill; however the low ANC of the S/S products reveals that there may be leaching in the long-term. The sand used in the mortar samples adversely affected the S/S performance, causing higher heavy metal leaching levels, and lower pH levels in the leachate after the TCLP extraction than those measured in the leachate of the paste samples.

Keywords: Dust stabilization; Sand; TCLP; SPLP

1. Introduction

Steel is produced in more than 50 countries worldwide and in every continent except Antarctica (IISI, 2006). In 2005 approximately 1129.4 million metric tons of steel was produced worldwide (IISI, 2006). Steel is made via two basic routes: a) from raw materials (iron ore, limestone and coke) by blast and basic oxygen furnaces, and b) from scrap via the electric arc furnace method. About 45% of the steel produced today is made with the electric arc furnace method (AISI, 2001).

Electric arc furnace dust (EAFD) is generated in considerable amounts by the electric arc steelmaking process. During melting in an electric arc furnace, certain elements volatilize, and after cooling, these elements form a fine dust. This dust, called EAFD, is collected in a baghouse and amounts to approximately 2% of the steel produced (AISI, 2001). In Turkey 20.961 million tons of steel was produced in 2005 (IISI, 2006) with 64% of plants equipped with electric arc furnaces (Orhan, 2005), generating 268,300 tons of electric arc furnace dust in Turkey in 1 year.

The chemical composition of EAFD was investigated by several researchers, and the most abundant heavy metals in EAFD were found to be Zn, Pb, Cr, and Cd (Pereira et al., 2001; Pelino et al., 2002; Sofilic et al., 2004; Orhan, 2005). Because of the leaching potential of the heavy metals it contains, EAFD has been designated by Turkey, the European Union (EU), and the EPA (United States Environmental Protection Agency) as a hazardous waste, which means that it cannot be disposed of at landfills without treatment.

Hazardous waste is either incinerated or disposed of at a hazardous waste disposal site in Turkey. EAFD has a low

*Corresponding author. Tel.: +90 224 4428177/+90 532 7496505; fax: +90 224 4429148.
E-mail addresses: gurays@uludag.edu.tr (G. Salihoglu), pinarli@uludag.edu.tr (V. Pinarli), nkamils@uludag.edu.tr (N.K. Salihoglu), geker@uludag.edu.tr (G. Karaca).

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