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Steel foundry electric arc furnace dust management: Stabilization by using lime and Portland cement

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Abstract

The purpose of this study was to determine an appropriate treatment for steel foundry electric arc furnace dust (EAFD) prior to permanent disposal. Lime and Portland cement (PC)-based stabilization was applied to treat the EAFD that contains lead and zinc above the landfilling limits, and is listed by USEPA as hazardous waste designation K061 and by EU as 10 02 07. Three types of paste samples were prepared with EAFD content varying between 0 and 90%. The first type contained the EAFD and Portland cement, the second contained the EAFD, Portland cement, and lime, and the third contained the EAFD and lime. All the samples were subjected to toxicity characteristics leaching procedure (TCLP) after an air-curing period of 28 days. pH changes were monitored and acid neutralization capacity of the samples were examined. Treatment effectiveness was evaluated in terms of reducing the heavy metal leachability to the levels below the USEPA landfilling criteria. An optimum composition for the EAFD stabilization was formulated as 30% EAFD +35% lime +35% Portland cement to achieve the landfilling criteria. The pH interval, where the solubility of the heavy metals in the EAFD was minimized, was found to be between 8.2 and 9.4.

Keywords: Hazardous; Cement; Lime; Leaching; pH control; Landfilling

1. Introduction

Steel industry plays an important role in the industrialization and development of a country, as it has the input within all manufacturing sectors. Turkish iron and steel sector, whose base was established in the 1930s, plays an important role in the industrialization and development of Turkish economy. Turkey is the largest importer of scrap in the world, importing over 13 million tonnes of scrap and producing 21 million tonnes of steel in 2005 [1]. Sixty-nine percent of the total steel production is realized by electric arc furnaces.

One of the most important problems encountered in steel foundries throughout the world is the management of the dusts produced from the electric arc furnaces. Extremely fine dust is formed in the electric arc furnace by metal vaporization, which is collected in the baghouse. In a typical electric arc furnace operation, approximately 2% of the charge is converted to dust [2]. Since metals such as zinc (Zn) and lead (Pb) are highly volatile at the temperature of molten steel, they are concentrated in the furnace dust.

Electric arc furnace dust (EAFD) generated during steel production is regarded as a hazardous waste because of the presence of significant amounts of leachable compounds of heavy metals such as Zn and Pb. EAFD is listed as a hazardous waste by the regulations of most of the countries.

The seriousness of the management problem arises from the fact that EAFD is generated in considerable amounts and its annual output is constantly increasing. 268,300 tonnes of electric arc furnace dust was generated in Turkey, in 2005. It is highly questionable if the EAFD generated is managed properly. The common practice in Turkey is collecting the EAFD in the open sites near the plants without taking sufficient precautions. EAFD is disposed of at some plants after wetting or pelletizing with water to facilitate its handling and to prevent wind dispersal. However, collecting the EAFD is just a partial solution to the management problem; the hazardous characteristics of the dust necessitate treatment before disposal of at landfills.

EAFD is a well-known waste. Several researchers [3–5] studied on the characterization of EAFD, in detail. The chemical

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