Trash to treasure: Turning steel-mill waste into bricks

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Scientists are reporting development and successful testing of a promising new way of using a troublesome byproduct of the global steel industry as raw materials for bricks that can be used in construction projects. Their study appears in ACS' *Industrial & Engineering Chemistry Research*.

In the report, Ana Andrés and colleagues note that steel mills around the world produce vast quantities of waste dust each year — 8 million – 12 million tons in the United States, for instance, and 700,000 tons in the European Union countries. The dust often is converted into a rock-like material known as Waelz slag, which is usually disposed of in landfills.

The slag contains iron, calcium, silicon oxide and other minor oxides as manganese, lead or zinc oxide. Scientists have been searching for practical and safe uses for Waelz slag. In earlier research, scientists showed that Waelz slag had potential as an ingredient in bricks, roof tiles and other ceramic products. The new research moves large-scale recycling of Waelz slag closer to reality, establishing at two real-world brick factories that the material can successfully be incorporated into commercial-size bricks.

It showed existing commercial equipment could be used to make bricks with Waelz slag, and eased concerns about large amounts of potentially toxic metals leaching out of such bricks. A small amount of potentially toxic material came out of the slag-made bricks over time, not in excess of European Union regulations. "Overall, it may be summarized that

Waelz slag containing bricks meet the highest quality standards set for construction ceramic materials," the researchers say.

More information: Incorporation of Waelz Slag into Commercial Ceramic Bricks: A Practical Example of Industrial Ecology, Ind. Eng. Chem. Res., 2011, 50 (9), pp 5806–5814. DOI: 10.1021/ie102145h

Abstract

The recovery of electric arc furnace (EAF) dust generates large amounts of an industrial byproduct called Waelz slag. This residue, consisting primarily of iron oxide contaminated with other metal oxides (including zinc and lead), is usually disposed of in landfill sites at a high economic and environmental cost. This paper investigates an alternative based on industrial ecology principles, which involves the incorporation of Waelz slag into clay ceramic construction bricks. For the purpose of this work, Waelz slag and raw materials employed in the manufacture of ceramic bricks (natural clays, wood pulp) were characterized. Subsequently, a series of brick specimens were manufactured according to commercial mixes and using industrial equipment and procedures. Similar specimens were also produced replacing 20–30 wt % of the clay with Waelz slag. The resulting products were analyzed for their physical (bulk density, water absorption, open porosity), mechanical (modulus of rupture), and chemical properties (soluble salts content) in order to evaluate compliance with quality standards for construction materials. The environmental consequences of incorporating slag into ceramic products were also investigated at three stages of their life cycle: release of potentially toxic species during their use (NEN 7345), leaching of heavy metals after disposal in landfill sites (EN 12457 1 and 2), and emission of atmospheric pollutants during the firing process. The experimental results demonstrate that incorporation of Waelz slag does not deteriorate the physical, mechanical, and chemical properties of the resulting products. The leaching of species during its useful lives show compliance with threshold values established according to the Dutch

Building Materials Decree (DBMD), and Waelz slag containing bricks fall into the category of nonhazardous waste landfill, just like conventional bricks used at this work. Emissions of CO2 and NOx were reduced versus the emissions of halogenated gases and SO2, which were favored due to the thermal decomposition of S, Cl, and F contained in the waste material.

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