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DEVELOPMENT OF EXTRUDED AND FIRED BRICKS WITH STEEL INDUSTRY BYPRODUCT TOWARDS CIRCULAR ECONOMY

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ABSTRACT

In the present research, the development of building bricks is examined, using steel industry electric arc furnace dust (EAFD) as admixture into standard clayey raw materials typically used by ceramic industries, and employing a pilot-plant simulation of industrial processes for red brick manufacturing,. The recycling of solid residues, which are derived in massive quantities from steel production plants, as alternative raw materials towards circular economy, is of increasing importance. In particular, steel dust recovered from EAF gas treatment, contains several oxides and, thus, can be considered as secondary material for substituting clays in traditional brick manufacturing. Possible economic benefits for the energy intensive industrial ceramic sector from energy savings upon firing along with a high potential for environmentally safe management of steel dust should be emphasized. For that purpose, various clay/EAFD mixtures were prepared and mixed with water to form a plastic mass for brick specimen shaping by extrusion. The green specimens were dried, and then fired at different peak temperatures (850, 950 and 1050^{o}C) in a controlled laboratory chamber furnace for sintering and consolidation. The effect of the by-product content (%) and of the firing temperature on brick shrinkage, bulk density, water absorption capability, mechanical strength and thermal conductivity was investigated. According to the results, the development of extruded and fired bricks with up to 15 wt.% recycled steel industry byproduct is feasible without significant variations in their technological properties.

Keywords: Building bricks, steel industry byproduct, extrusion, firing, characterization.

INTRODUCTION

The aim of "closing the loop" of product lifecycles through greater recycling, by safely turning waste byproducts from an industry into useful secondary resources for another industrial sector is strongly encouraged by current European Union policies, towards industrial symbiosis, ample coordination and circular economy.

Huge quantities of clays are annually needed for the production of considerable amounts of fired ceramic bricks worldwide, and therefore much research focuses on the utilization of alternative raw materials from various origins into clay mixtures, at different combinations and proportions, for the fabrication of conventional sintered bricks [1-3].

On the other side, management and valorization of massive quantities of solid residues recovered in steelmaking plants worldwide, such as electric arc furnace dust, electric arc furnace slag and ladle furnace slag, represent a significant issue. In steel industry, the production of 1 ton of steel results in generation of 2-4 tons of various types of waste by-products [4], while 1 ton of stainless steel waste is produced per 3 tons of stainless steelmaking [5]. Taking into account the quantities of steel by-products, their proper disposal and handling remains both dangerous and expensive task, and therefore, their safe utilization can be environmentally and financially beneficial. Blast furnace slag and steel slag are already competitive raw materials in the mineral industry, and blast furnace slag use in the cement industry currently increases, resulting in production cost reduction. Also, electric arc furnace slag is widely used in the road and pavement construction and is recently studied for the development of vitreous ceramic tiles [4,6,7].

Especially, the recycling of electric arc furnace dust (EAFD) is very important, because it is one of the major steel by-products, included in the European Waste Catalogue [8], and produced