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REWASTEE: MANUFACTURING ECO-INNOVATIVE CONSTRUCTION PRODUCTS FROM STEEL MANUFACTURING WASTE*

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Abstract

Europe produces large amount of EAFD, an hazardous, toxic waste with elevated environmental and economic disposal costs. Currently 60-65% of the produce EAFD ends up in authorized landfills and constitute a significant cost for mills and for the society. The current paper presents the progress to date of a research project to incorporate EAFD into insulation material to provide thermal and acoustic properties. The invention arises from the University of Barcelona and the University of Lleida (custodians of the patent) and consists in encapsulating EAFD as inorganic filler in a polymeric matrix to create a dense final "non-hazardous" material with excellent sound insulation for various applications (both alone and coupled to other materials). The addition of Phase Changing Materials (PCM) also provides thermal properties such as thermal inertia. The EU-funded research project aims at the industrial validation, launch and replication of the technology that combines recycling with the production of building multifunctional products bringing benefits in environmental and construction market and introducing a new Eco-Innovative product.

Keywords: acoustic insulation, bioPCM, EAFD recycling, steel waste, thermal insulation, thermal regulation

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1. Introduction

Current statistics shows that Europe is the second largest steel producer in the world with a production of 168 million tons in 2012. The main producers are Germany, Italy, France, Spain, and UK, which account together for 64.7% of EU steel production (Egenhofer et al., 2013). An amount representing 41.6% of EU steel is produced by electric methods, involving the generation of 10-20 kg of Electric Arc Furnace Dust (EAFD) per ton of steel produced (http://www.nobatek.com/downloads/actu/REWASTEE_KoM.pdf). EAFD is a well-known waste of the steelmaking industry, but considered a hazardous waste according to the European Waste Catalogue (EWC) with limited to date recycling alternatives (Barreneche et al., 2013; Fontes Vieira et al., 2014).

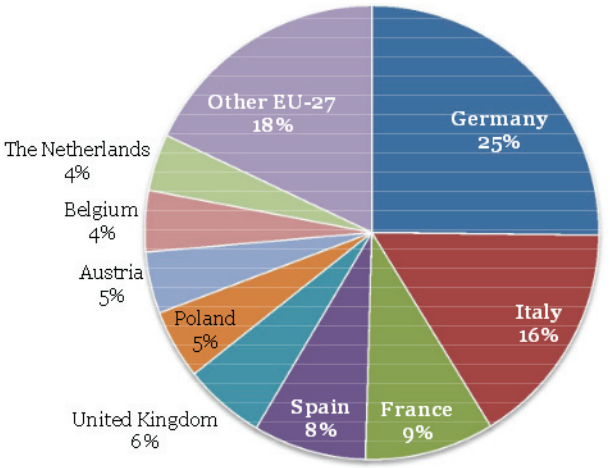

Fig. 1. Share of crude steel production in the EU by member state, 2012 (Egenhofer et al., 2013)

Typically, EAF steel producers currently have two major options: Processing the dust in a metal recovery facility to extract Zinc (the rest is then disposed in landfills) or chemically stabilize it and landfill it (with no metal recovery). The fraction of EAFD recycled varies for every country and region. In Spain, the recycled fraction of EAFD is below 20%, while European average is 50%. Being Europe the 2nd largest EAFD producer (1.3 million tons in 2012), EAFD has become a major waste concern due to the environmental and economic disposal costs. Opposite to the current practices on EAFD stabilization, where EAFD is a cost for EAF steel producers with no possibility of further use, the proposed use offers a way to obtain revenues from the produced EAFD. One very promising route it to incorporate in insulation material providing excellent physical and acoustic properties.

The EU project (REWASTEE, www.rewastee.eu), funded under the Eco-innovation initiative of the European Union (contract number ECO/13/630286), aims to recover Electric Arc Furnace Dust (EAFD) generated during steel making and reincorporate it in the productive cycle, to obtain and bring into the market a multifunctional building insulation material having physical, acoustic properties as well as enhanced thermal inertia (when coupled with PCM) (Barreneche et al., 2013). The project is piloting and manufacturing the innovative insulation material that will be launched into the markets at the beginning of 2017. The project

consortium is composed by 8 project partners including research center (EURECAT, Nobatek, BRE), universities (University of Barcelona and University of Lleida) and private companies (R2M Solution, Trimdelson Trade S.L., FCC Construction) ranging the full range of expertise required (Barreneche et al., 2014; Fernández et al., 2010).

2. Materials and methods

The process consists in the incorporation of EAFD into a polymer layer of EPDM and optionally also PCM. During the inertization process EAFD is completely stabilized forming dense sheets/layers by lamination, thus achieving a building multifunctional material.

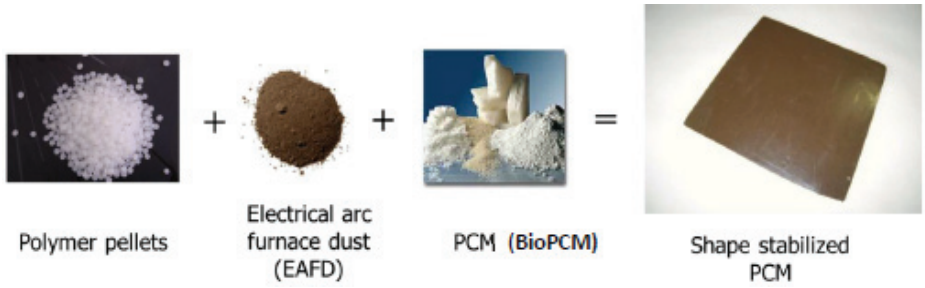

Fig. 2. Pictures of the raw materials and final product

The developed manufacturing process allows the EAFD stabilization and the manufacturing of building material in a single production line at industrial scale (and in the same facility) by using a broadly extended and standardized equipment (typically used for processing and producing rubber sheets), avoiding extra cost derived of transport to the production site, waste treatment (stabilization) or management. It also contributes to the implementation of a multifunctional material in the construction sector that improves energy efficiency of buildings, according to the commitment of the European Directive 2010/31/EC on energy performance of buildings (EC Directive, 2010).

3. Current status and next steps

Several stakeholders (e.g., steel manufacturers, construction companies, insulation product manufacturers) would benefit from the success of the innovative idea to recycle EAFD and incorporate it into insulation material (Fig. 3).

The team's current activities consist of material prototyping, manufacturing process optimization and the initial fabrication of integrated building products. Different manufacturing conditions and material compositions, including different PCM %, were tested to define the preferred one. Mechanical characterization, following UNE ISO-37, as well as apparent dynamic stiffness and damping ratio, following BS EN ISO 9052 -1 1992, have been already performed with the selected products. Steady and transient thermal response of the chosen material compositions will be tested at the University of Lleida to characterize their performance. In parallel, market analysis and business planning activities are identifying which commercial route the consortium should target first. This includes establishing contacts with a number of steel producers and material manufacturers in order to develop potential collaboration opportunities.

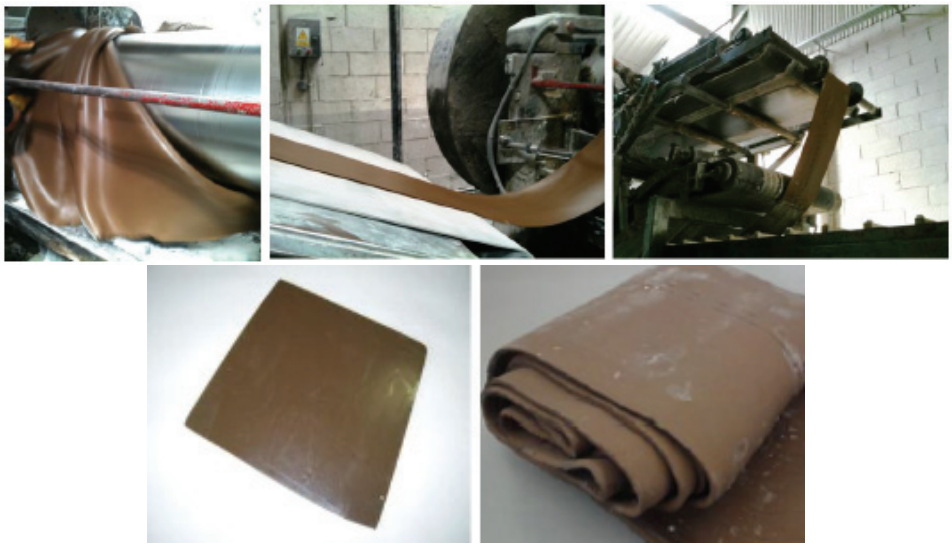

Fig. 3. Pictures of production of final product at Trimdelson Trade S.L. facilities

Fig. 4. Principal stakeholders

4. Concluding remarks

Europe generates significant amount of EAFD, a hazardous material that is currently for its majority landfilled. With the proposed method we provide benefits to several stakeholders and extract value from an otherwise waste with significant economic and environmental benefits. Results to date foster the confidence to be able to develop an interesting insulation material to support the circular economy principles that could enter the construction product market around the beginning of 2017.

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