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Increased “green value” of porcelain stoneware tiles through the eco-design of raw materials

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The ceramic industry is a materials- and energy-intensive sector due to the manufacturing process itself which requires, in addition to mineral raw materials, huge volumes of water that evaporates during the production cycle and significant amounts of fuel for atomization, drying and firing. A careful choice of energy sources, both in terms of thermal and electric, is essential in order to reduce the overall environmental impact of the product.

In addition to energetic issues, an accurate selection of raw materials, considering their environmental impact, has the potential to significantly increase the final “green value” of the product. With these premises, this study was aimed at assessing the environmental sustainability of porcelain stoneware tiles considering different scenarios for the supply of raw materials, in order to evaluate whether and to what extent the use of local and nearby raw materials could improve the environmental performances of the tiles. An important and non-secondary benefit of this design approach is the valorization of alternative raw materials not considered before.

As a first step of the analysis, different alternatives in terms of composition were analyzed from a chemical and microstructural point of view, with the aim of ensuring the technical and technological feasibility of the product and its final performances.

Samples were obtained by standard powder processing routes and sintering conditions (1200 °C, 45 min) and technological parameters were measured in order to assure compliance with the requirements of the BIa class.

Based on the sample formulations, different life cycle processes have been modelled, considering the different ceramic body compositions and the relative supply of raw materials, without changing the other phases along the life cycle; this in order to evaluate the incidence of the raw

materials on the results. Three alternatives with 63%, 42% and 20% of extra-EU raw materials respectively have been compared, with their relative means of transport. The environmental impact of the alternatives was assessed with the Life Cycle Assessment methodology, considering the entire life cycle of the tiles. The results highlighted that the scenario with 63% of extra-EU raw materials had the higher impacts, decreasing for the second and third scenarios by 2.8% and 9.1% respectively. This analysis underlined the importance of the design phase of the ceramic body that can reduce the overall environmental damages due to shorter supply distances of raw materials and more sustainable types of transportation (i.e. train). Both technological and environmental sustainability are fundamental to ensure the feasibility of a product and represent a guide towards the design and manufacturing of more sustainable products.

Keywords: Porcelain stoneware tiles, Eco-design approach, Raw materials, Life Cycle Assessment