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Recycling of firewood ash waste in ceramic floor tiles with low water absorption

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A large amount of firewood ash waste is produced in the Brazilian red ceramic industry from the firing process. The friendly recycling of this solid waste material is considered to be a matter of great technical, economical, and environmental importance. This work aims to evaluate the use of firewood ash waste as an alternative raw material into a ceramic floor tile body, replacing natural quartz material by up to 10 wt.%. For this purpose, firewood ash waste coming from a red ceramic plant in Campos dos Goytacazes-RJ (southeast region of Brazil) was selected and its chemical and mineralogical characteristics determined. Floor tile bodies containing up to 10 wt.% of firewood ash waste were prepared by the dry process, pressed, and fired between 1190 °C and 1250 °C using a fast-firing cycle. The ceramic bodies were characterized in terms of particle size distribution and physical parameters (true density, apparent density, vibrated density, and Hausner index). The floor tile pieces were tested to determine their properties (linear shrinkage, water absorption, apparent porosity, apparent density, and flexural strength). It was found that the firewood ash waste is a non-plastic material with complex mineral composition, including calcite, portlandite, calcium sulfate, calcium oxide, quartz, potassium carbonate, hydrated magnesium sulphate, and hematite. The results also showed that the partial replacement of quartz with firewood ash waste, in the range up to 10 wt.%, allows the production of ceramic floor tiles with low water absorption (WA) (B1a group - $WA < 0.5\%$ and B1b group - $0.5 < WA < 3\%$; ISO 13006 Standard) in different amounts of firewood ash waste at lower firing temperatures. Such results suggest a new possibility for friendly recycling of firewood ash waste as a source of alternative renewable raw material in the production of high quality ceramic floor tiles.