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SUBSTITUTION OF RAW MATERIALS IN DIFFERENT CERAMIC INDUSTRIAL PRODUCTS

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ABSTRACT

The sludge, coming from the industrial polishing process of porcelain stoneware tiles, are an interesting waste to recycle in ceramic tile body mix as their chemical and mineralogical composition is quite similar to the slurry in which they are added. The polishing sludge contains ceramic material debris and residues of the grinding wheels, such as calcium and magnesium carbonate and silicon carbide. These last components could negatively affect both the rheology of the silps and the microstucture of the fired samples. Aim of this work is the study of the suspensions properties of mixes for porcelain stoneware and porous single-firing tile containing polishing sludge.

Different amounts of polishing sludge are used as substitute of the feldspar components of the ceramic mixes and the rheological behaviour of the corresponding concentrated suspensions is studied, in order to optimise the recycling process. The raw materials and the recycled sludge are characterised by chemical and mineralogical analysis. The prepared slips are characterised by particle size and pH measurements, the rheological behaviours is studied with a rotazional rheometer. The results show how the addition of the sludge leads to an increase of alkali ions, such as magnesium, in the slips of porcelain stoneware slips. In general, clays suspensions are flocculated in the presence of higher valence cations, like magnesium or calcium, as they create a network between the particles. This structure is evidenced by the study of viscosity and the time dependent behaviour (yield stress and thixotropy). The oscillatory measurements underline this kind of structuring, as the suspensions (in particular the porcelain stoneware slips) become gel–like. This behaviour points out that destabilisation effects occur in the system. For the porous single-firing mix, due to the fact that the ions concentration doesn't change significantly, the observed coagulation of the suspension has to be attributed to the fine particle size of the sludge. In this case, the increase of surface area, due to a suspension particle size reduction, needs to increment the deflocculant concentration.

The firing behaviour, in terms of shrinkage and water absorption, of the samples is correlated with the added sludge amount. For the porcelain stoneware mix, the presence of the sludge cause a decreasing of the sintering temperature, even if the shrinkage trend is slightly less constant, compared to the standard sample. For the porous single-firing mix, no significant differences are found in the firing behaviour of modified and standard products.

The results obtained underline that it is possible to recycle percentages of sludge around 10% as substitute of feldspar raw materials, for porcelain stoneware products without decreasing the product characteristics. This percentage may decrease to around 5%, in the case of porous single-firing products.