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Recycling of thermically treated asbestos-containing material in the production of sanitary-ware vitreous bodies

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Asbestos-containing material (ACM) still represents an emergency in Europe because of the related health problems. Based on dedicated legislation, ACM must be managed through several different operations such as: i) confinement, ii) encapsulation and iii) removal (with disposal in controlled landfills). A more attractive alternative to these non-ideal solutions, safer and sustainable, is the transformation of the ACM through thermal, thermo-chemical or thermo-mechanical methods into a non-hazardous secondary raw material. In this contribution, we explore the re-use of ACM thermally treated at 1100 °C in the production of sanitary ware ceramics.

Sanitary-ware vitreous bodies (VB) are generally obtained from mixtures of three fundamental raw materials: i) clay, mostly kaolinite, which provides plasticity to the ceramic mixture; ii) quartz, which acts as filler, forming the skeletal network of the ceramic body; iii) feldspar, a fluxing agent, which promotes the greification of the body and the dissolution of component like quartz upon firing (buller T 1200-1240 °C; Carty & Senapati, 1998).

The product of the thermally treated ACM, i.e. a mixture of non-hazardous Ca-Mg-rich silicates (akermanite, bredigite, merwinite and larnite) and glass, was added to a ceramic mixture as a partial substitute (5 wt%) of feldspar (mixture VBX), and characterized according to a standard protocol before and after firing in the industrial tunnel kiln (buller T 1230°C). The results pointed out a very good greification level of the VBX slip, as corroborated by very low water absorption. These results motivated us to better evaluate the greification behavior of the VBX slip at 6 different buller T by means of gradient kiln. From the mixture VBX, we prepared six samples which were heated at 1140, 1160, 1180, 1200, 1220, and 1240 °C, and characterized the mechanical, mineralogical and microstructural properties. For comparison, the same T steps and analyses were applied to six standard ceramic mixtures (i.e., vitreous China, VC).

XRPD indicates that VBX and VC have very similar mineralogical composition, with glass, quartz, feldspar and mullite as major constituents and minor Fe and Ti oxides. SEM observations suggest that VBX and VC have also similar microstructure, dominated by a glassy matrix embedding numerous 10-60 μm-sized particles of quartz, feldspar and mullite. Overall, thermally treated ACM

seems a good candidate to substitute feldspar up to 5 wt% in the production of sanitary ware ceramics. This conclusion is further supported by the fact that VBX and VC display a very similar greification level at T>1200°C.

Carty, W. M., & Senapati, U. (1998). Porcelain—raw materials, processing, phase evolution, and mechanical behavior. *Journal of the American Ceramic Society*, *81*(1), 3-20.