CHARACTERISATION OF INDUSTRIAL AND MINERAL WASTES AND THEIR USE IN CERAMIC BODY COMPOSITIONS

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SUMMARY

The industrial research in developing projects on environmental issues appears to focus on reducing the volume of waste arising during production, adopting the concept of clean production and reusing waste in developing new products or replacing noble raw materials.

The main outcome of the efforts made in this sense has been the preservation of natural raw materials resources, smaller waste disposal areas and widening of the range of products that can be made from these wastes.

In the ceramic tile industry the use of industrial waste is viewed as a promising reality. The main wastes considered in this sector come from the mining industry and from tile manufacturing. Assessment of the feasibility of using a given waste is based on waste physico-chemical characteristics during heating and particularly on its influence on ceramic body behaviour.

In the present work the feasibility was studied of using mining waste (granite, basalt and clay) and glazing waste in the composition of a ceramic body for making high-density products. The main characteristics if the typically illitic clay are its high Fe_2O_3 content (6%) and high plasticity. During sintering, at 1180°C, it exhibits a firing shrinkage of 5.9%, without any glassy phase formation being observed. During firing, the basalt and granite wastes present the typical behaviour of rock formations. Their main constituents are quartz and fluxing phases such as sodium and potassium feldspars, besides being characterised by a high iron content. The granite exhibits an Fe_2O_3 content of 2.7% and the basalt 11.4%. As a result of these factors, during sintering at 1180°C, the granite and basalt exhibit high firing shrinkage, 14.39% for the granite and 15.01% for the basalt. Both have a dark colour and pronounced glassy phase formation as a result of the high iron content, which is more marked in the case of the basalt. The presence of glassy phase brings water absorption down to 0%. The glazing waste, arising in the production of glazed ceramic tile, exhibits pronounced fluxing behaviour with a sintering shrinkage of 13%, attaining a water absorption of 0% with heat treatments at 1120°C.

These raw materials were used in preparing different ceramic bodies, using 20% clay as a base to provide them with plasticity to facilitate the compaction step, adding 10% glazing waste as a flux. The remaining 70% of the composition was made up of a combination of different granite and basalt contents. The mixtures were prepared in a fast laboratory mill using raw materials with an oversize on a 325-mesh screen of less than 3%. The specimens, sized 20x40mm, were produced by uniaxial pressing at a pressure of 25 MPa. Sintering heat treatments were carried out in the range 1000 to 1180°C

In the specimens sintered at 1140°C, the increase in basalt content and corresponding reduction in granite produced greater firing shrinkage and higher bulk density, and a drop in water absorption. This behaviour highlights the greater fluxing effect of the basalt. This effect, as a result of the basalt content, became less pronounced as sintering temperature was raised. The main evidence for this analysis lies in the fact that the basalt and granite acted in a similar fashion. With regard to basalt, this constituent tended to shift the densification or shrinkage curve, allowing lower sintering temperatures to be used.

The chemical behaviour of the resulting products was characterised, determining chemical resistance and stain resistance, as was their mechanical behaviour, determining scratch hardness and bending strength. The products all exhibited satisfactory results, which were compatible with commercial products.