USE OF SPODUMENE IN FABRICATING TECHNICAL PORCELAIN TILE BODIES

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1. INTRODUCTION

At present, companies that manufacture unglazed porcelain tile use at least two types of compositions to make the tiles. The most widely used body, known as the "Base" composition is formulated with clays, feldspars and feldspathic sand, and is essentially used for through-body colouring by means of calcined pigments.

In the second type of composition, which is known as the "Superwhite" body, part of the clay is replaced by kaolin with a view to reducing the colouring oxide content. Furthermore, zircon is added in variable percentages (3-8%) to increase whiteness. These compositions are mainly used for obtaining white colours as well as for applying soluble salts. However, their greater whiteness and opacity hamper colour development. Another feature to be noted of these compositions is that they display worse behaviour during the manufacturing process than the Base compositions: This leads to lower dry bulk densities, greater after-pressing expansion, lower dry mechanical strength as well as higher firing temperature and linear shrinkage.

The present study has been undertaken to develop a porcelain tile composition that combines the best features of each of these two types of bodies. That is, whiteness similar to that of the Superwhite compositions and processibility similar to that of the Base compositions, particularly with regard to behaviour during pressing and optimum firing temperature. It was furthermore sought to achieve a greater capacity for developing colours than currently available with the typical Superwhite and Base compositions.

2. MATERIALS AND EXPERIMENTAL DEVELOPMENT

After a preliminary study of formulations, a porcelain tile body was selected and prepared, referenced ALT, of whiteness similar to that of the Superwhite bodies, but behaving during the industrial process more like the Base body. The body has been formulated without kaolin, using the spodumene termed Gres-Flux, which contains approximately 6.5% Li_2O and a high percentage of feldspathic sand. Table 1 details the composition of the proposed body.

Raw material	Percentage
Clay mixture	34
Feldspar	38
Feldspathic sand	25.5
Gres-Flux spodumene	2.5

Table 1. Composition of the body referenced ALT.

To perform a comparative study, two porcelain tile bodies were selected, a Base and a Superwhite body, without any zirconium addition, which are currently used to manufacture technical porcelain tile.

These industrial bodies and the proposed body were used to form cylindrical test specimens at 500 kg/cm^2 and a moisture content of 5.5% (dry weight basis). After drying, the test specimens were fired at four peak firing temperatures (1190, 1200, 1210 and 1220°C) for 6 minutes. Linear shrinkage, water absorption, bulk density and chromatic coordinates of the fired specimens were then determined. These data were used to estimate the firing temperature at which maximum densification was attained for each body. As fired product properties, we took those obtained at a temperature of 1200°C, which is the standard working temperature for technical porcelain tile.

With a view to determining the influence of the composition on colour development capacity, 1.5% black pigment, 1.5% blue pigment and 2.0% pink pigment were added to the ALT and Base bodies. These bodies were pressed according to the above procedure and the resulting test specimens were fired at a firing temperature of 1200°C. Their chromatic coordinates were then determined. On the other hand, to determine the suitability of the ALT body for fabricating bodies of high whiteness, 4% zirconium silicate was added this body and to the Superwhite body.

3. RESULTS AND DISCUSSION

Table 2 summarizes the results obtained.

Analysis of the results shows that the ALT body displays a dry bulk density, firing temperature for maximum densification and fired linear shrinkage very similar to those of the Base body. These results indicate that its behaviour during the different manufacturing process stages is similar to that of the Base bodies, which was subsequently confirmed in an industrial trial.

On the other hand, the capacity of the proposed body to develop colour is much greater than that of the industrial Base body. Indeed, with the same pigment addition, more intense colours are obtained with the proposed body. Industrial trials have confirmed savings in pink and blue pigment of close to 20%.

If the ALT body is compared with the Superwhite body, the whiteness of the latter body at 1200°C is higher. However, it should be noted that this is due to its lesser vitrification; if the values of the L* coordinate obtained at maximum densification temperature are compared, the value of the Superwhite body is even slightly lower. Owing to the greater vitrification of the ALT body at 1200°C, the added zirconium silicate provides a greater increase in the L* coordinate, which is why the differences in whiteness with this additive are much smaller. The industrial trial confirmed the improvement in the processibility of the body and the characteristics of the end product, especially with regard to its stain resistance.

PROPERTY	ALT	BASE	SUPERWHITE
Dry bulk density	1.901	1.913	1.880
Maximum densification temperature	1202	1200	1220
Linear shrinkage at 1200°C	7.3	7.6	8.2
L* coordinate at 1200°C	77.3	75.4	79.3
a* coordinate at 1200°C	1.5	1.8	2.0
b* coordinate at 1200°C	11.0	12.1	11.0
L* coordinate (+4% zirconium) at 1200°C	82.1	-	82.7
L* coordinate (+1.5% black) at 1200°C	38.3	39.0	-
b* coordinate (+1.5% blue) at 1200°C	-19.5	-16.8	-
a* coordinate (+2.0% pink) at 1200°C	14.5	12.7	-

Table 2. Results.

4. CONCLUSIONS

A body has been developed that combines the best features of the Superwhite and Base bodies, i.e., processibility and high whiteness, but with a greater capacity to develop colours.

These characteristics have been obtained by reducing the quantity of clay to the minimum that enabled maintaining the processibility of the body. The suppressed quantity of clay was replaced by feldspathic sand, with a view to favouring the transparency of the body and reducing the total colouring oxide content. The increase in refractoriness that was provided by this last raw material was compensated by the introduction of a small percentage of Gres-Flux spodumene.

The industrial trials with the proposed body have been satisfactory both for fabricating models in which a coloured Base body is currently used and those in which a Superwhite body is employed. In addition to very important savings in the consumption of certain pigments, such as blue and pink, this can furthermore mean a reduction in the number of bodies used to make the different porcelain tile models and, therefore, in the number of raw materials used.