USE OF WOLLASTONITE IN EARTHENWARE WALL TILE MANUFACTURE

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1. INTRODUCTION

Wollastonite is a natural raw material made up of calcium silicate ($CaSiO_3$), which can be used to contribute CaO to white-firing earthenware wall tile body compositions [1].

The raw materials currently used to contribute CaO to this type of product are calcite and dolomite [2], which is why the use of wollastonite could entail a reduction of the firing cycle since there are no decomposition reactions at high temperature (850-950°C). This work presents a comparative study of compositions with calcite and wollastonite, in which the properties of the fired product have been determined, as well as the shortening of the firing cycle and the CO_2 emissions related with the use of wollastonite.

2. EXPERIMENTAL

The study was conducted with a standard composition currently used in earthenware wall tile manufacture (AZ-STD), in which the calcite and feldspathic sand were replaced with wollastonite (AZ-1). Both compositions had the same CaO content in the fired product.

The compositions were characterised on a laboratory scale by determining their pressing and firing behaviour, as well as the properties of the fired product. Finally, the compositions were processed on a pilot scale to evaluate the reduction of the firing cycle.

Composition	AZ-STD	AZ-1
National clay	44	44
Imported clay	10	10
Feldspathic sand	25	22
Kaolin	10	10
Calcium carbonate	11	-
Wollastonite	-	14

Table 1. Tested compositions (% by weight).

3. RESULTS

Figure 1 shows the dimensional changes of both compositions during heating and cooling. The most noteworthy aspect is the interruption of tile shrinkage with $CaCO_3$ at 950°C as a result of the generation of CO_2 and the crystallisation of calcium aluminosilicates. This effect is not observed in the composition with wollastonite, despite the formation of anorthite caused by the reaction of wollastonite with the dehydroxylated clay mineral.

Table 2 presents the properties of the tiles at a temperature of 1140ºC. It may be observed that the AZ-1 composition provides higher linear shrinkage and lower water absorption values compared with those of the AZ-STD composition. The variation of shrinkage with temperature is slightly higher in the wollastonite-containing composition, which could facilitate the obtainment of flat pieces by acting on the kiln.

The lower porosity of the composition with wollastonite is mainly due to its lower loss on ignition, and it provides the tiles with higher fired mechanical strength and slightly lower moisture expansion.

Figure 2 shows the firing cycle used in discontinuous pilot-scale roller kiln to fire glazed tiles made with composition AZ-STD. The firing cycle displays high heating rates except in the temperature range between 900 and 1000ºC, in which calcite decomposition takes place without glaze sealing. Modifying the heating rate in this stretch enables a first estimation to be made of the possible shortening of the firing cycle with the use of wollastonite.

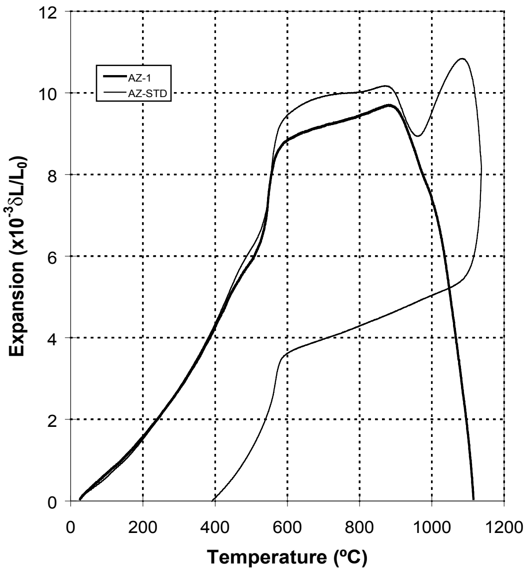

Figure 1. Expansion-shrinkage curves.

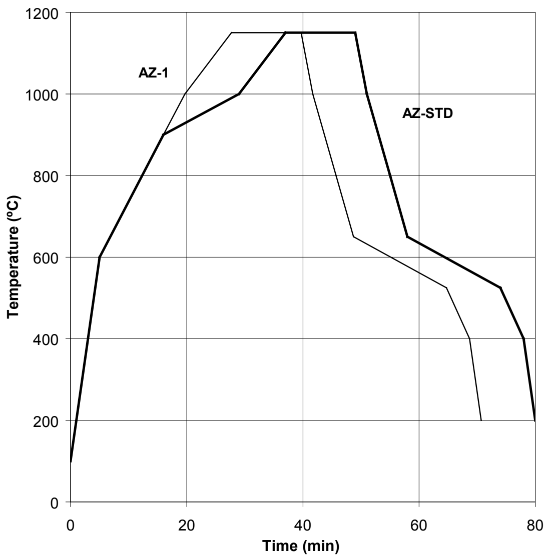

Figure 2. Thermal cycles used.

The maximum heating rate, in this range of temperatures, which yielded tiles of composition AZ-STD without pinholes was 7.5ºC/min, while for tiles of composition AZ-1 this was 27ºC/min. This increase in heating rate involves a 12% shortening of the firing cycle when calcium carbonate is replaced with wollastonite. The energy saving obtained with the wollastonite-containing composition, evaluated on the basis of natural gas consumption, was 12.5%. This, together with the absence of the calcite decomposition reaction, leads to a 14% decrease in CO_2 emissions.

Composition	AZ-STD	AZ-1
Linear shrinkage (%)	0.11	1.40
Water absorption (%)	17.3	12.8
Loss on ignition (%)	9.10	4.50
Bulk density (g/cm³)	1.793	1.964
Fired mechanical strength (kg/cm²)	180	230
Moisure expansion (‰)	1.1	0.8

Table 2. Properties at a temperature of 1140ºC.

4. CONCLUSIONS

The results obtained allow the conclusion to be drawn that the use of wollastonite in white-firing earthenware wall tile body compositions is technically feasible and, in addition, provides a series of advantages, such as greater mechanical strength and lower moisture expansion of the bodies, as well as the possibility of shortening the firing cycle. As a result, this increases the productivity of the facility, decreases costs (overheads and energy), and reduces CO_2 emissions.

Owing to the higher price of wollastonite, this material should be used for products with high added value, such as large-sized tiles, which, as a result of the glazes used, require long firing cycles and usually exhibit delayed curvatures.

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