DEVELOPMENT OF A NEW SYSTEM FOR CERAMIC WASTE RECYCLING

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1. INTRODUCTION

This study sets out the results obtained in the project "Development of a new system for ceramic waste recycling" conducted by the company Maincer with the Instituto de Tecnología Cerámica (ITC) in the frame of the Valencian Institute for Business Competitiveness (IVACE) aid to companies.

In ceramic tile manufacturing, a series of ceramic wastes are generated in different process stages. These wastes can be broken down into two large groups as a function of their nature: unfired waste and fired waste. This study focuses on recycling unfired ceramic waste.

The current system involved in recycling such unfired ceramic waste has two main **disadvantages**: the need for transport from the tile manufacturing companies at which the waste is generated to the spray-drying and waste reprocessing (milling + spray drying) facilities, which entails use of key resources: water and electric power for milling, and thermal energy for spray drying.

This project has allowed determination of the physical characteristics that the waste must display to enable in-situ recycling, i.e. directly in the pressing stage, and of the recycling procedure that has led to the construction of a mobile prototype with which pilot trials were carried out to validate it.

2. EXPERIMENTAL

2.1. VARIABLES STUDIED IN THE PROTOTYPE

In the initial pilot-scale validation trials of the prototype (Figure 1a), the different types of ceramic waste generated in the industry (unfired tile scrap; unfired glazed tile scrap; powder; and a mixture of all the types of non-powder waste, referenced GLOBAL) in two typical compositions: red-body stoneware tile and porcelain tile, were analysed. In addition, the influence of the moisture content of the materials on the dry grinding process was also analysed

The following grinding mill variables were studied: rotation speed (10, 25, and 50 inverter) and output sieve (0.7, 1, and 2 mm), analysing their influence on the resulting size distribution after milling, as well as on morphology, flowability, and residue.

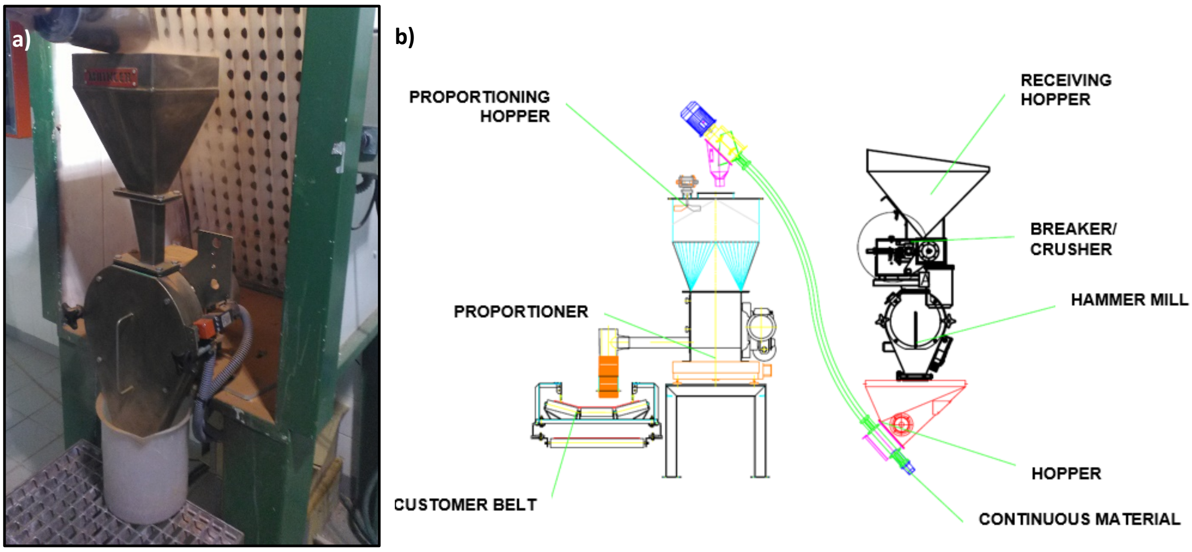

Figure 1. *a) Mobile prototype installed in the laboratory. b) Industrial in-plant installation scheme.*

2.2. INDUSTRIAL VALIDATION

Once the optimum milling conditions for each type of material had been defined, industrial-scale trials were run (Figure 1b). These milling trials were performed with the material referenced GLOBAL (which included all the types of non-powder waste). The resulting milled material (with a size below 700 microns) was mixed with the powder waste to form the material referenced GLOBAL C, in the following proportions:

- 80% non-powder waste (material processed in the prototype)
- 10% bag filter dust
- 10% press powder, repressing

The material reprocessed in the prototype (GLOBAL C) was added to the belt that conveyed the spray-dried powder to the presses, using the proportioning hopper illustrated in the scheme (Figure 1b). Two industrial trials were conducted, adding 2 and 4% recycled tile scrap.

3. RESULTS

The main results obtained in the pilot-scale experimental stage were as follows:

- Mill rotation speed influenced the amount of fines and residue percentage obtained above 600 μm, but not particle surface morphology (Figure 2a).
- The rotation speed in the optimum milling process for stoneware tile differed from that for porcelain tile.
- The choice of output sieve mesh aperture enabled the residue percentage to be reduced, the optimum sieve mesh aperture being 700 μm.
- Tile scrap moisture content (about 2% on a dry basis) did not affect grinding.

The following results were obtained in the industrial trials:

- Spray-dried powder moisture content decreased (0.3%) after the tile scrap addition, only minimal readjustment of pressing pressure being required.
- The particle size distribution of the material with the waste addition resembled that of the standard material (Figure 2b).
- No segregations of the material were observed in the waste addition, thanks to the homogenisation achieved between the conveyor belts and the addition point.
- The tiles exhibited no defects relating to the waste addition after firing.

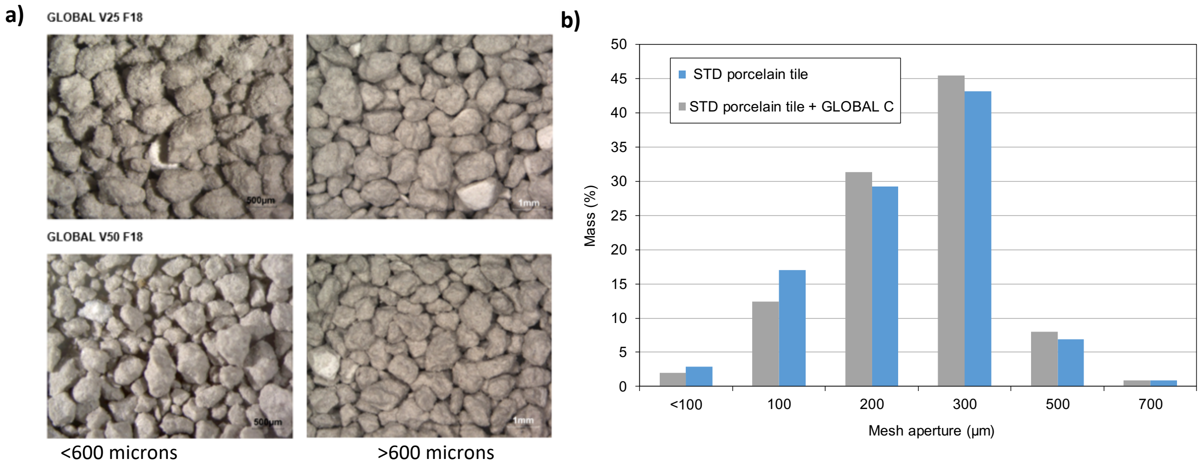

Figure 2. *a) Image of the recycled reprocessed waste. b) Comparison of the size distribution of the STD material and the STD material with the recycled waste addition.*

4. CONCLUSIONS

The main advantages of the proposed system with respect to the waste management process currently being used at the companies are as follows:

- The waste is recycled at the company that generates it, without requiring transport to outside spray-drying facilities.
- Waste treatment for recycling is simpler and less expensive than that for current recycling, as it only requires size reduction of the tile scrap by the proposed system. The system requires little energy as the scrap is unfired, having only been pressed. In contrast, the current system requires fully reprocessing the waste (wet milling, sieving of the suspension, and spray drying).
- The waste can be consumed "in real time", i.e. the waste can be consumed as it arises, as recycling takes place at the facility where it is generated. This also eliminates stocks of waste.
- The recycling system is flexible and allows larger or smaller amounts of waste to be recycled as a function of the product (ceramic tile) being made.
- The recycled waste addition entails a reduction in raw materials costs owing to the decrease in amount of spray-dried powder. This leads directly to lower CO_2 emissions in the ceramic spray-drying process.

5. REFERENCES

[1] GARCÍA, J.; QUEREDA, P.; MALLOL, G.; SORIANO, M.L.; VICENT, M. Desarrollo de baldosas cerámicas para pavimentación urbana basadas en residuos industriales. Técnica Cerámica, 389, 126-131, 2011.

[2] MESTRE, S.; SÁNCHEZ, E.; GARCÍA-TEN, J; SÁNCHEZ, J.; SOLER, C.; PORTOLÉS, J.; SALES, J. Utilización de la teoría de Kubelka-Munk para optimizar el reciclado de residuos crudos de gres porcelánico. Bol. Soc. Esp. Ceram. Vidr., 41(4), 429-435, 2002.

[3] MONFORT, E.; GARCÍA-TEN, J.; VELASCO, P.; MONZÓ, M.; MESTRE, S.; JARQUE, J.C. Reciclado de tiesto en composiciones de pavimento y revestimiento rojo (I). Técnica Cerámica, 292, 450-458, 2001.