STUDY OF PORCELAIN TILE STAIN RESISTANCE

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1. ABSTRACT

Within the range of different types of ceramic tiles that are manufactured worldwide, the type known as porcelain tile stands out, due to its excellent technical properties (low water absorption, high mechanical strength and resistance to abrasion, excellent chemical and frost resistance) and its similarity to natural stones. With the development and improvement of new decorating techniques, it is possible to make products with a sophisticated design, highly resembling certain natural stones, such as marbles and granites, but at a more accessible market price. This type of tile includes unglazed products (commonly known as technical porcelain tile) and glazed products. Unglazed porcelain tile generally exhibits water absorption of less than 0.1%, while glazed products can exhibit water absorption below 0.5%.

Porcelain tile can be classified as natural, polished and glazed. The polished product is subjected to a polishing stage during the manufacturing process. During this stage the material acquires gloss, an aesthetic characteristic appreciated by consumers. In polishing, some closed pores scattered inside the piece are opened at the surface, causing stain resistance to decrease, and hence surface deterioration with use.[1,2]

Porcelain tile stainability is at the moment one of its most critical technical characteristics, and the objective of this work has been to evaluate the stain resistance of national and imported, glazed, natural and polished porcelain tiles, on exposure to different staining agents set out in Brazilian Standard NBR 13818[3]/ISO 10545, and to staining agents that simulate real conditions of use (such as mustard, coffee, vinegar, car oil, and grease), not contained in this standard, as well as verifying the possibility of cleaning the stains using household cleaning products.

2. EXPERIMENTAL PROCEDURE

Technical products "tinta unita" (plain tiles) and "salt and pepper", and two glazed products, one with a rough surface and another with a smooth surface were selected. The studied products were of Brazilian and imported origin.

The stain resistance of the porcelain tile and granites was evaluated by means of assessing their cleanability after applying the staining agents to the ceramic tile surface, in accordance with the test set out in Brazilian Standard NBR 13818 - Annex G (ISO 10545). The evaluation of stain resistance to substances simulating daily conditions of use was conducted in a similar way to the test method of Brazilian Standard NBR 13818 - Annex G, with certain alterations. The modifications were designed to facilitate test performance. These tests were carried out on light coloured "tinta unita" products (NPBRAN, EPNEV and IPPAR). Three samples were used for each type of tested staining agent. The following staining agents were used: Coffee, Mustard, "Catsup", English Sauce, Car oil, Grease, Ballpoint pen ink and Vinegar. Household cleaning products were also used as cleaning agents. The classification of cleaning was only made by characterising the stain as removable or non-removable, owing to the impossibility of classifying cleanability in terms of Brazilian Standard NBR 13818.

To calculate true and closed porosity of the samples being studied, it was necessary to determine true specific gravity by a helium pycnometer, with a Quantachrome, Ultrapycnometer 1000 instrument. The determination of apparent porosity of the samples of the studied porcelain tiles was carried out with the method involving Archimedes' principle, measuring dry sample weight, wet weight, and weight of the sample immersed in water after two hours' boiling. These weight data enabled determining the fraction corresponding to apparent (f_{PA}), true (f_{PT}) and closed porosity (f_{PF}).

The appearance of the stains and surface porosity were evaluated on a Leica MZ12 stereomicroscope coupled to an image analyser (Leica Qwin). Side lateral illumination was used. Microstructural analyses were performed on a scanning electron microscope (SEM).

3. RESULTS AND CONCLUSIONS

The results found in this study show that the polished porcelain tile samples can exhibit high susceptibility particularly to staining by penetrating agents. The factors affecting product stain resistance are: quantity of closed pores, pore sizes, depth of the pores, roughness of the inner pore surface and distribution of porosity at the product surface.

The greater the quantity, size and depth of the pores, the greater is staining agent fixing, and therefore the more difficult it is to remove the stains. If the pores are homogeneously distributed in the product surface, the appearance of the stain is also homogeneous, as verified in a studied Brazilian product. But, if pore distribution is heterogeneous, the stain is concentrated in the regions with the greatest number of large, deep pores, further impairing the appearance of the product.

Some Brazilian products exhibited high stain resistance because they had pores with a very different morphology. The pores were full of material similar to the composition of the matrix, while porosity was also smaller and well distributed.

The polishing process can adversely affect product susceptibility to staining, because it can cause granule pullout and lead to microcracks in the porcelain tile glassy matrix.

Film forming agents are generally removable with the action of a common neutral detergent.

To increase porcelain tile stain resistance, it is possible to:

- Improve particle packing in the pressing stage, by adjusting the particle-size distribution curve of the spray-dried powder.

- Adjust glassy-phase viscosity so that bubble formation during firing is reduced, since as porcelain tile firing is rapid, bubbles do not have enough time to escape.

- Adjust maximum firing temperature to keep pores from merging, which can occur at very high temperatures.

- Study the polishing process and types of abrasives used to minimise the damage caused to the surface to be polished such as: granule pullout, microcrack formation and scratching.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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