CLOSED POROSITY IN PORCELAIN TILE

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The work presents the effect of processing conditions – granulate size distribution, pressing conditions and firing temperature on the closed porosity of porcelain tile, as well as a description of how the pores are distributed throughout the pieces. The interest in studying porosity is mainly related to porcelain tile stain resistance[1].

A single accumulated industrial body was used for the study. The data corresponding to the groups of samples used are presented in Table I. For the study of each process condition, the other two conditions were kept constant as far as possible.

Study	Sample	Granule size (ϕ μm)	Density (g/cm³)	Temperature (°C)
Granule size	STD	**Original**	1.88	1212
	F	**ϕ <212**	1.88	1212
	M	**212<ϕ<420**	1.88	1212
	T	**ϕ >420**	1.88	1212
	STD-F*	**ϕ >212**	1.90	1212
Density	STD-F*	ϕ >212	**1.70**	1212
	STD-F*	ϕ >212	**1.80**	1212
	STD-F*	ϕ >212	**1.90**	1212
Temperature	STD	original	1.88	**1150**
	STD	original	1.88	**1175**
	STD	original	1.88	**1190**
	STD	original	1.88	**1200**
	STD	original	1.88	**1212**
	STD	original	1.88	**1225**

* STD composition free of fine fractions

Table I: Characteristics of the groups of test samples.

Closed porosity was evaluated based on images of abraded and polished tile surfaces (5-7 mm), taken with an optical microscope, by image analysis[2]. Results were obtained relating to the total area of the pore images (pore volume) and also to pore size distribution.

The data are summed up graphically in Figures 1 to 4; the value in brackets in the box corresponds to pore image area – a larger value than the value found for pore volume with a helium pycnometer, as a result of the difference existing between the product proper surface and side surface (see Figure 1).

The main conclusions of the work are: a) pores are distributed throughout the whole volume of the pieces, including immediately under the surface; b) pore shape is oriented as a function of the pressing stage, which makes them flat and not round; c) a smaller pore volume was found, with a smaller size distribution in the composition with the original granule size distribution, free of granule sizes smaller than 212 μm (Figures 2 and 3); d) with regard to compaction, there seems to be a minimum sealed porosity volume that cannot be eliminated by a increase in density, although density has a great effect on porosity in the compaction range before this limit (Figure 3); d) it is fundamental to know how porosity behaves in relation to firing temperature, as the minimum porosity range is found in a relatively narrow temperature range (Figure 4).

Finally, in the stain resistance tests (NBR 13818), it was confirmed that the best values (5 for all the agents) were found for the STD-F compositions (1.80 and 1.90 g/cm³), corresponding to the smallest found incidences of pores and also to the smallest size distributions.

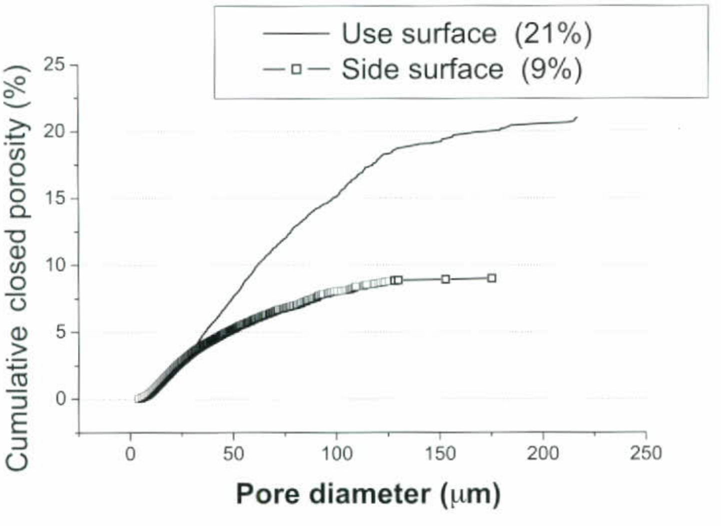

Figure 1: Pore size distribution in perpendicular surfaces in the same piece.

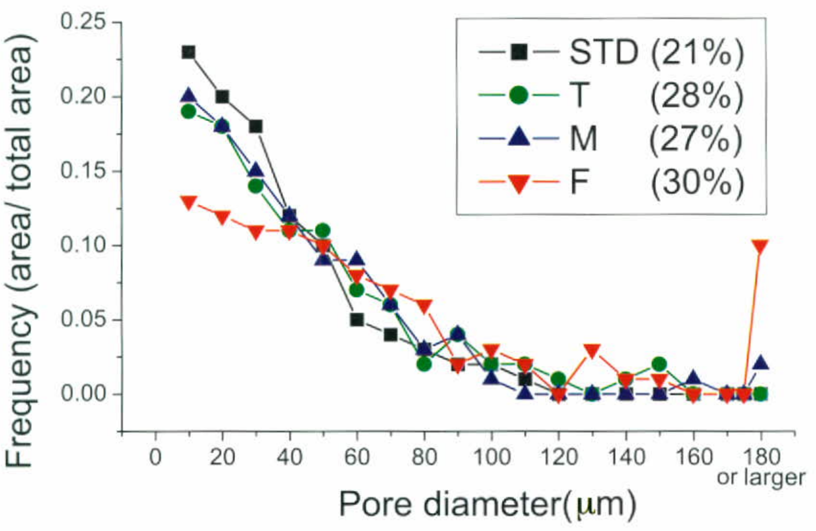

Figure 2: Pore size distribution frequency found for compositions with different granule size distributions.

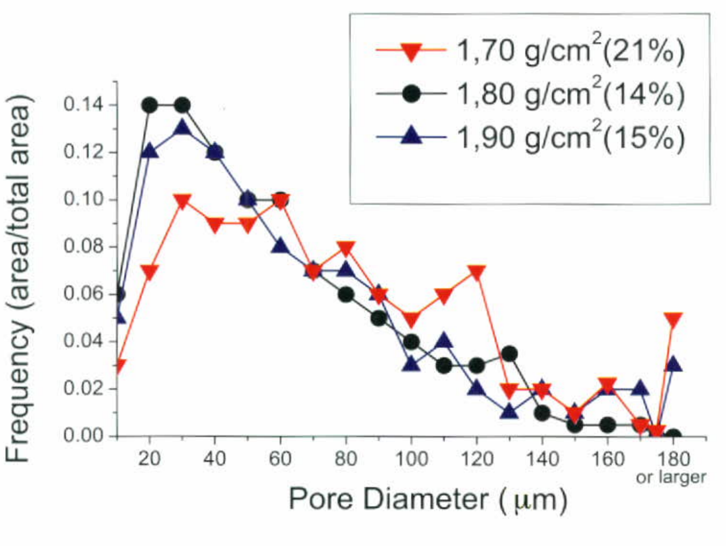

Figure 3: Pore size distribution frequency found at the different studied densities.

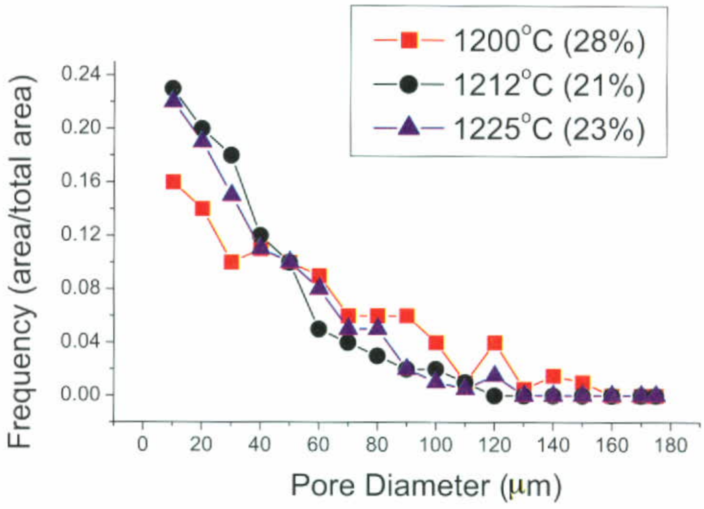

Figure 4: Pore size distribution frequency found in the different temperature ranges.

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[2] ARANTES, F.J.S.; GALESI, D.F.; QUINTEIRO, E.; BOSCHI, A.O. "O Manchamento e a Porosidade Fechada de Grês Porcelanato" Cerâmica Industrial, Vol 6(3), pp. 18-26 (2001) ISSN: 1443-4608.