VARIATION IN PERMEABILITY AND ITS RELATIONSHIP WITH THE CHARACTERISTICS OF THE PORES IN CERAMIC COMPACTS DURING FIRING

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1. INTRODUCTION

Permeability is a property related to the ease of percolation of a fluid through a porous solid or a set of particles in a compact. During firing of ceramic products there may be reactions which result in the release of gases. The balance of said reactions depends on the outflow of these gases and this depends on the permeability of the compact particles (1). Permeability, in turn, depends on the arrangement of the particles, which changes considerably during firing (2). If the permeability of the compact is not sufficient to allow the outflow of the gases, these will remain trapped inside the compact and may give rise to several defects which compromise the quality of the pieces produced. Therefore, to prevent these defects, it is essential to understand the permeability evolution during firing as a consequence of the change in the porous structure of the compact. In this context, the aim of this paper was to characterize the permeability evolution in porcelain stoneware pastes during firing and correlate it with changes in the characteristics of the pores present in the compact.

2. MATERIALS AND METHODS

Two porcelain stoneware pastes were assessed: P1 and P2. These were ground in laboratory ball mills until a fixed residue of 2 to 5 % was achieved in a sieve with an opening of 63 µm. Then, the pastes were pressed with a humidity of 6.5 % and a pressure of 380 kgf/cm^2. Then, the permeability of the test bodies fired at 750 °C, 850 °C, 950 °C, 1050 °C, 1100 °C and 1150 °C was analysed. The tests were performed using a permeameter following the stationary flow method, measuring the air flow and its pressure values on inflow into and outflow from the test piece. Using Forchheimer's equation for incompressible fluids, it was possible to determine the value of the k1 and k2 constants, which are characteristic of porous media and do not depend on the type of fluid nor the velocity of the flow. Water absorption of the fired pieces was assessed using the Archimedes method. Mercury porosimetry tests were also performed. The intrusion diameter left by the penetration of half the total volume of mercury that penetrated in the samples was taken as the average diameter of the pores.

3. RESULTS AND DISCUSSION

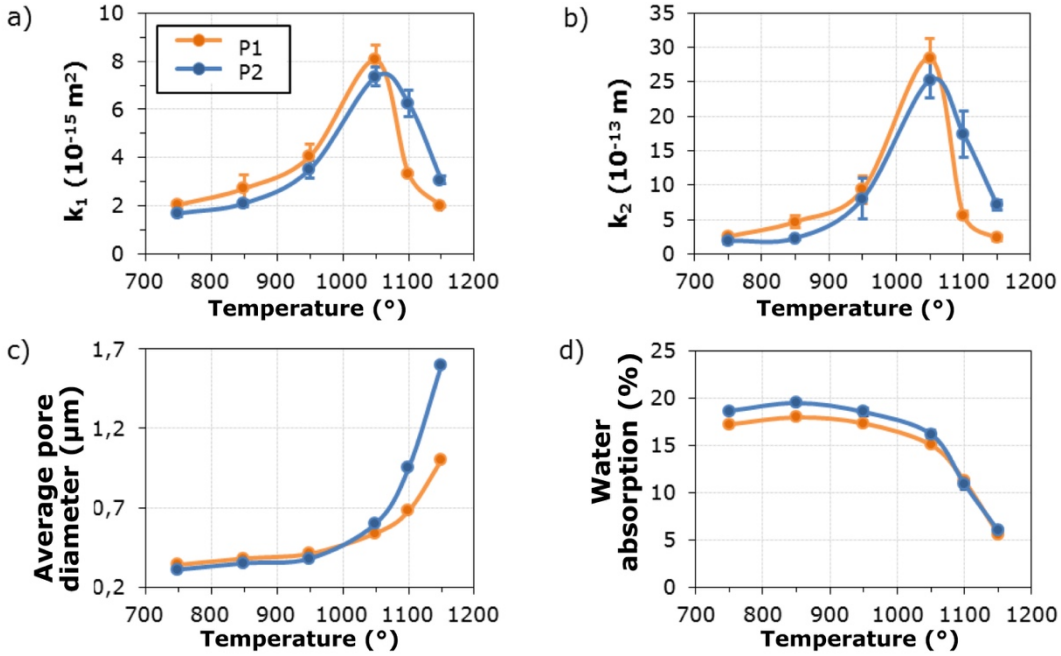

Figure 1. *Graph of k1 (a), k2 (b), average diameter of the pore (c) and water absorption (d) of the test pieces prepared with the P1 and P2 pastes assessed.*

It is possible to observe in the graphs for k1 and k2 two regions in which the permeability of the compact presents totally different behaviours. At the temperatures in which sintering starts for the two pastes, the average size of the pore increases with firing temperature and, consequently, the permeability of the pastes increases. On the other hand, with the increase in temperature, water absorption is reduced. When this reaches lower levels, the very reduced permeable porosity of the compact becomes a limiting factor for permeability of the test bodies. From that point on, as absorption diminishes with temperature, permeability is also reduced. However, it cannot be said that the size of the pores fails to be relevant. The diameter of the pores, at those higher

temperatures, grows significantly. For paste 2, this growth occurs at a greater speed. With it, despite the reduction in permeable porosity, the larger size of the open pores still remaining in the compact contributes to the fact that the reduction in permeability in paste 2 occurs to a lesser extent than in paste 1.

4. CONCLUSIONS

In the pastes studied, the behaviour of k1 and k2 is influenced by two characteristics in the porous structure of the compact differently in the two intervals. The permeability of a compact increases as the pore size increases during firing and reaches a maximum at a certain temperature. For higher temperatures, the reduction in permeable porosity limits permeability, which begins to reduce with temperature. These results indicate that the characterization of the evolution of permeability during firing may be a useful tool for comparing the performance of ceramic pastes and acting on solving problems associated with degasification of the medium.

5. BIBLIOGRAPHICAL REFERENCES

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