THE INFLUENCE OF VADU CRIŞULUI KAOLIN ON TECHNOLOGICAL CHARACTERISTICS AND MICROSTRUCTURE OF SILICA PORCELAIN

GOREA, M.[1], KRISTÁLY, F.[2] & ZAJZON, N.[2]
[1] Department of Chemical Engineering and Oxide Material Science, Babeş-Bolyai University, Arany János Str. no. 11, RO-400028 Cluj-Napoca, Romania
E-mail: mgorea@chem.ubbcluj.ro
[2] Department of Mineralogy and Petrology, University of Miskolc, H-3515 Mikolc-Egyetemváros, Hungary

Porcelain has been used as an electrical insulating material since a long time due to its specific properties (mechanical strength, high-power dielectric strength, and corrosion resistance). Two types of porcelain insulators are mostly used, the silica and alumina porcelain (classified as C-110 and C-120 sub-groups, respectively, according to the IEC 672-3 standard). In the silica porcelain body the solid quartz content is higher than in that of the alumina porcelain and, correspondingly, its mechanical strength is greater. The difference between thermal expansion of the quartz grains and the surrounding liquid phase causes mechanical stress that can produce, during thermal treatment, microcracks in the porcelain.

The main raw materials used for obtaining traditional porcelains are kaolins (about 50%), feldspar (25%) and quartz (25%). The clay acts as a binder for the other constituents in the raw materials mixture, and it confers plasticity to the body for shaping. Feldspar is a flux material that reacts with the other compounds, forms a liquid phase in the system and leads to densification of the body microstructure. Quartz is a refractory material, stable filler that reduces distortion and shrinkage of the ceramics during the thermal treatment.

The final microstructure of the fired porcelain consists of coarse aggregate particles held together by a finer matrix or bond system that is dense.

The goal of this paper is to study the influence of Vadu Crişului kaolin, used as a replacement for other clay materials, on the technological characteristics and microstructure of silica electrical porcelain. The experiments are focused on two aspects: characterization of Vadu Crişului kaolin and synthesis and characterization of three compositions of porcelain.

The chemical composition of Vadu Crişului kaolin is presented in Table 1.

Results of the semi-quantitative mineralogical analysis: quartz – 11%; kaolinite – 78%; illite/micas – 9%; iron oxides and hidroxides – 2%.

The main technological characteristics are: Pffeferkorn plasticity index – 41.10%; bending strength – 24 daN/cm^2; total shrinkage – 19%; whiteness – 45%.

The experimental compositions also include other clay raw materials: Bojidar, KDH and Zettlitz kaolin, as well as the nonplastic materials, AC-type feldspar and Miorcani quartz-rich sand. The first composition contains 43% clayey materials (no Vadu Crişului kaolin), with a feldspar/sand (F/S) ratio 1.28; the second composition includes 47.5% clayey materials (21% Vadu Crişului kaolin) with a F/S ratio of 1.28; the third composition consists of 46.5% clayey materials (10.75% Vadu Crişului kaolin) with a F/S ratio of 1.37. The main technological characteristics of the ceramic masses have similar values.

The microstructure of the porcelain bodies obtained from the three compositions was further investigated by EDS analyses combined with SEM observations. EDS analyses were carried out on the vitreous matrix of the bodies, delimited by the use of BSE images, in order to establish the Si/Al ratio and content of Na and K of the matrix, which is determined by the initial clay component and feldspar dispersion in the volume of ceramic body before firing. The porosity of porcelain strongly depends on the variation of Si/Al ratio and alkali content of the vitreous matrix. Thus, porosity deduced from SEM images, correlated with the composition of the matrix shows the influence of clay components on the microstructure of porcelain body.

Table 1: Chemical composition of Vadu Crişului kaolin.

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	L.O.I.
52.99	31.35	1.43	0.66	0.53	0.09	1.09	11.46