USING KAOLIN WASTE IN CERAMIC TILE MANUFACTURE

Wilson Acchar[1,2] and Lana Lopes de Souza[2]

[1]Department of Physics, Federal University of Rio Grande do Norte (UFRN),
Natal-RN, Brazil,
acchar@dfte.ufrn.br
[2]Pos-Graduation Program of Mechanical Engineering,
Federal University of Rio Grande do Norte,
Natal-RN, Brazil.

The industrial activities are actually responsible for the production of large amounts of solid wastes. The use of industrial wastes into ceramic activities has been widely developed. Waste materials such as power plant ashes, aluminum anodizing sludge, foundry sands, granite, marble, pegmatite has been used as additives or as an alternative raw materials[1-10]. The raw materials used in the traditional ceramic industries consisted basically of plastic components (clay), fluxing components (feldspar) and inert components (quartz and sand). The clay materials used in the ceramic industry present a large diversification of compositions, what allow the addition of different types of waste materials in the clay mixture. Besides the of ornamental stones waste, produced by cutting process, kaolin waste are becoming a worrying factor for the ceramic industry in Rio Grande do Norte-Brazil. The wastes materials are discarded into rivers and lagoons, without any treatment, causing a critical environmental problem. This work describes research carried out on the manufacturing of ceramic tile materials with kaolin waste additions. The waste and the clay materials were collected directly in the ceramic industry. The clay material presents a typical composition and are constituted mainly by silica and alumina and minor contents of Fe,Mg,Ti,Ca,Na and K oxides. The kaolin waste is formed basically by SiO_2 and Al_2O_3, with small amounts of MgO, Fe_2O_3 and K_2O. The alkaline earth oxide content (particularly MgO and K_2O), present in the waste material will act as a fluxing agent during the sintering process. Clay with 30 and 35 wt. % kaolin waste content were mixed in a ball mill, pressed in a metallic die under a load of approximately 20 MPa and sintered at temperatures between 1175 and 1300ºC. The concentration of 30 and 35 wt. % present an adequate plasticity index (Fig. 1). Higher kaolin waste content will cause a decrease of the plasticity index. Sintered specimens were characterized by porosity and water absorption. Strength measurements were also performed in a three point bending test, using a universal testing machine, at a cross-head speed of 0.5 mm/min (average of five specimens for each value). The results obtained showed that the kaolin waste can be added to the clay materials, without degrading significantly their properties. The porosity values decreases significantly by increasing the sintering temperature, regardless the kaolin waste (Table 1). This behavior is related to the lower viscosity of the liquid phase and the consequently improvement on the densification process produced at these temperatures. The presence of the kaolin content has the opposite effect. The porosity values increases by increasing the kaolin content, what can relate to the higher Al_2O_3 content caused by the addition of the kaolin. Table 1 shows also the variation of the flexural strength as a function of the kaolin content and sintering temperature. Strength values are increased by higher sintering temperatures, as expected. The incorporation of kaolin waste causes a decrease of the flexural strength that can be attributed to the increase of the porosity level. Figure 2 shows the fracture surface of the clay + 30 wt. % kaolin waste. The material presents a homogeneous structure and a small porosity level. No presence of agglomerates or inclusions were identified in the microstructural analyzes. The results obtained in this work show that waste content up to 35 wt.% can be incorporated into clay materials, without degrading significant their mechanical properties. The possibility to use kaolin waste as an alternative raw material in the production of clay products will also induce a relief on waste disposal concerns and to minimize the negative impact of the ceramic industry on the environment in Rio Grande do Norte, Brazil.

TEMPERATURE [ºC]	POROSITY [%]	WATER ABSORPTION [%]	FLEXURAL STRENGTH [MPa]
1175	25 – 30	16 – 18	5± 1 – 4±0.8
1200	23 – 28	12 – 15	7±1.5 – 6±2
1250	18 – 22	10 – 11	10± 2 – 9±1.5
1300	13 - 15	7 – 8	13± 2– 11±1.5
30 wt. % Kaolin – 35 wt. % Kaolin			

Table 1. Results obtained in this work.

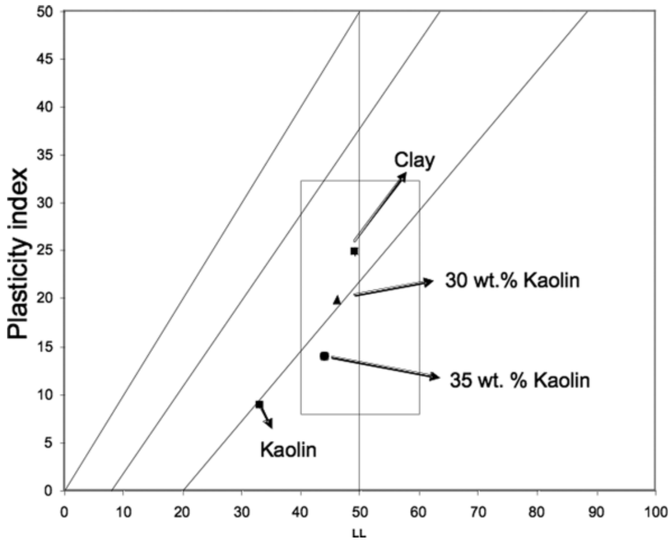

Figure 1. Plasticity index of the investigated materials.

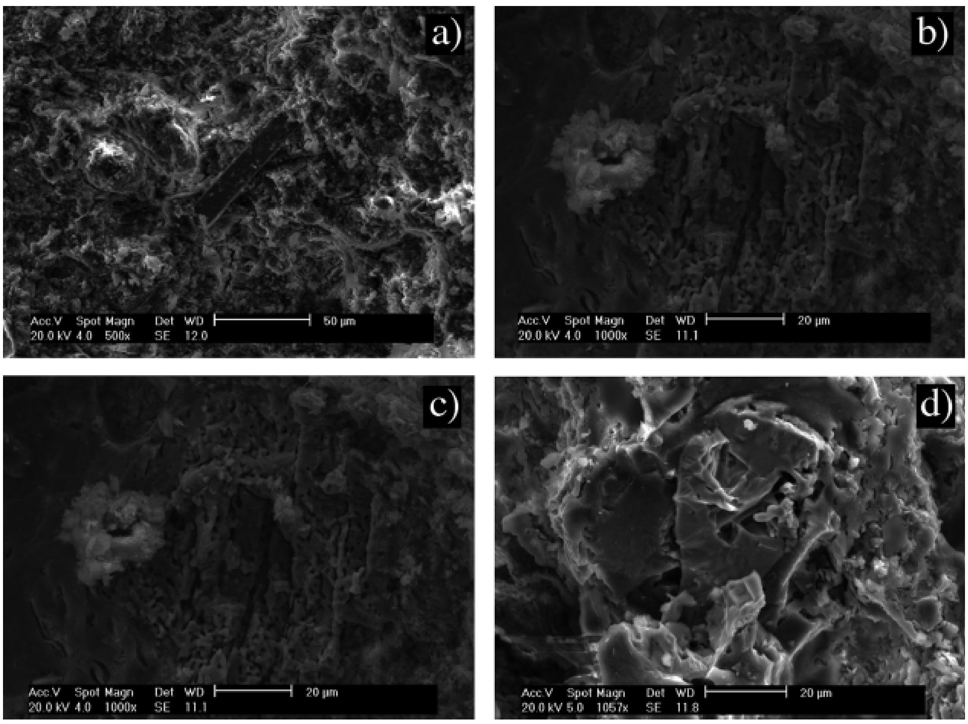

Figure 2. Fracture surface of the: a) 1175ºC b) 1200ºC c) 1250ºC and d) 1300ºC

REFERENCES

[1] A.Gorokhovsky, V.Gorokhovsky and D.Mescheryakov, Glass Sci.Technol. Vol. 73 (2000), p.374.

[2] M.Dondi,M.Marsigli and B.Fabbri, Tile &Brick Int. Vol. 13 (1997),p. 302.

[3] N.I.W.Silva,O. Zwonok and F.Chies, Tile&Brick Int. Vol. 14 (1998), p. 247.

[4] H.A.Oliveira,E.C.Rabelo and J.C.Bressiani, Tile&Brick Vol. 17 (2001), p. 29.

[5] J.M. Ferreira, H.M.Alves and A.M.Mendonça, Bulletin de la Sociedad Espanola de Cerâmica y Vidro Vol.38 (1999), p. 127.

[6] J.M.Ferreira and S.M.Olhero, J.Europ.Ceram.Soc Vol. 22 (2002), p. 2243.

[7] S.N.Monteiro,L.A.Peçanha and C.M.F.Vieira, J.Europ.Ceram.Soc Vol. 24 (2004), p. 2349.

[8] M.S.Hernadez-Crespo and J.M.Rincón, Ceramurgia Vol. 3-4 (2001) 111.

[9] T. Hatzl and P. Gehiken, ZI Vol.12 (2001), p. 20.

[10] W.Acchar,F.A.Vieira and D.Hotza, Effect of marble and granite sludge in clay materials, Mat.Sci. & Eng A, Vol. 419 (2006), p.306.