PYROPLASTIC DEFORMATION AND FUSIBILITY OF LITIFIED CLAYS AND THEIR RELATIONSHIP WITH CLAY CHEMICAL COMPOSITION

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1. INTRODUCTION

Litified clays are widely used in Brazil for red stoneware production and, sometimes, for the production of glazed porcelain tile. Their use contributes moderate plasticity, great vitrification capacity, and ease of deflocculation and milling. Their composition is basically that of a clay, but they have a stony appearance owing to the geological litification process. This last feature usually assures a composition with a high content in potassium and other network-modifying oxides. In firing, glassy phase develops which, on the one hand, assures the obtainment of low water absorption but, on the other, can lead to pyroplastic deformation of the ceramic tile. Greater or lesser pyroplastic deformation is related to factors such as the quantity and viscosity of the arising liquid phase, and body porosity, in addition to variables such as tile thickness and spacing between the supports (in industrial kilns, distance between the rollers). The materials supplied by mining companies are accompanied by a technical characterisation (vitrification diagram and colour after firing) and information on the chemical composition of the raw materials. However, the characteristics in relation to pyroplasticity are hardly tested; nor is the mineralogical composition of this type of material characterised. As a result, there is a relative lack of knowledge between the chemical composition vs. pyroplasticity (PI) vs. vitrification capacity (VC) and which network-modifying oxides are most-closely related to vitrification and which of these are most-closely related to pyroplasticity for this type of raw material.

2. RESULTS AND CONCLUSIONS

Eight different litified clays were chosen, whose chemical and mineralogical composition had been characterised. Test pieces of 80x20mm were prepared and subjected to different firing temperatures (between 1070 and 1190ºC) for the determination of the vitrification diagram and the pyroplasticity index (PI) (the greater the curvature defection, the greater the PI). VC was considered to be the temperature required by the material to attain 0.5% water absorption (the higher the temperature, the lower the VC).

3. RESULTS AND CONCLUSIONS

The results indicate that the studied litified clays were mainly made up of quartz, illite, and muscovite mica. The sum of the modifying oxides (Fe_2O_3, Na_2O, K_2O, CaO, and MgO) in their chemical compositions, table 1, varied between 6,3 and 12,8%. The PI varied between 0,4 and 2,8 cm^{-1}, while the VC varied between 1110ºC and 1200ºC. No significant correlation was observed (R=-0,43) between the PI and the VC, though the following general trend was observed: the higher the VC, the larger the PI. On the other hand, a significant correlation

was observed between the VC and the PI with the sum of the oxides (R=0,81 for both variables). After data stratification, it was observed that the oxides with the greatest tendency to decrease glassy phase viscosity (Na_2O, K_2O) displayed the greatest correlation with the pyroplasticity index, while the vitrification capacity was correlated (R=0,90) with the ionic radius of the metal that constituted the oxide: that is, the smaller the ionic radius, the greater the vitrification capacity. (Ionic radius: Fe<Mg<Na<Ca<K).

Raw material	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	MgO	MnO	TiO_2	P_2O_5	P.F.	∑MR
A	67,89	14.34	4.16	0.62	1.63	4.42	1.96	0.07	0.55	0.2	4.17	12.79
B	68.6	14.81	3.8	0.11	10.05	6.36	1.12	0.04	0.57	0.06	3.48	12.44
C	68.34	15.67	4.2	0.05	0.43	4.73	1.31	0.05	0.56	0.06	4.59	10.72
D	68.57	14.88	4.82	0.12	0.84	3.32	1.5	-	0.54	-	5.08	10.6
E	71.37	13.85	3.33	0.31	1.1	4,26	1.42	-	0.5	-	3.86	10.42
F	70.34	14.14	4.82	0.26	0.42	2,67	1.59	0.05	0.57	0.07	5.07	9.76
G	68.89	18.49	1.95	-	0.04	3.62	1.09	-	0.62	-	5.3	6.7
H	65.11	21.44	2.19	0.11	0.05	2.98	0.92	-	0.48	-	6.72	6.25

Table 1. Chemical composition of the studied litified clays.

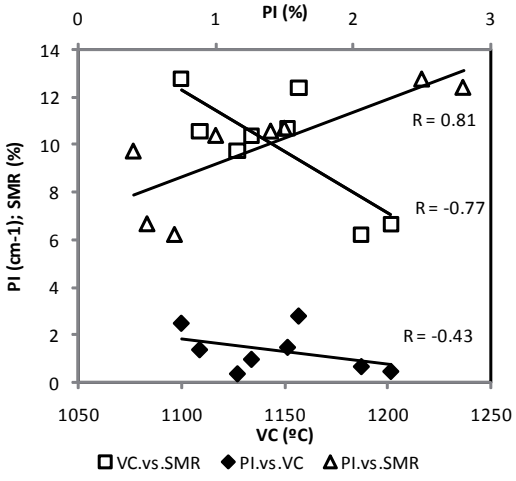

Figure 1. Diagram of P.I.vs.VC;PI.vs.∑MR;VC.vs.∑MR scatter.

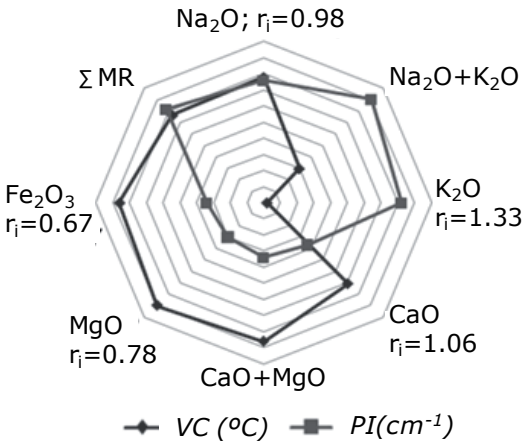

Figure 2. Correlation coefficients for PI and VC vs. each network-modifying oxide and the oxide groups (∑MR, Na+K, Ca+Mg and respective ionic radii (r_i)).

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