COMPARATIVE STUDY OF ADDING DIFFERENT ALUMINAS TO CERAMIC GLAZES AND ENGOBES

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This study was undertaken with a view to establishing how the addition of different aluminas (with different particle size, surface area and chemical composition) affected the fusibility and final characteristics of the engobes and glazes. For this, test compositions were selected, referenced Original Compositions (CO), which are used industrially, of the following product types: opaque glaze (ESO), transparent glaze (EST), porcelain tile glaze (ESP), permeable engobe (ENP) and impermeable engobe (ENI).

We varied the alumina proportion in the Original Composition of each glaze and engobe (Table 1), preparing the suspensions by milling and comparatively evaluating the fusibility of each type of added alumina (Table 2). For this, fusion test specimens were made by fusing in gypsum moulds. The dry test specimens were fired at different temperatures, around the industrial working temperature of each starting product, and a clear improvement was obtained in the whiteness/sintering and impermeabilization of the engobes and glazes.

	% ALUMINA BY WEIGHT								
	Original Composition(CO)	CO – 3%	CO – 2%	CO – 1%	CO + 1%	CO + 2%	CO + 3%	CO + 4%	CO + 6%
ESO	2	---	0	1	3	4	---	6	---
EST	0	---	---	---	1	2	3	---	6
ESP	1	---	---	0	2	3	---	---	7
ENP	5	2	---	4	6	---	8	---	---
ENI	5	2	---	4	6	---	8	---	---

Table 1. Quantities of aluminas tested in the different types of glaze and engobes.

Calcined alumina	% de Al_2O_3	LOI (%)	Surface area (m^2/g)	% alpha phase	Particle size distribution		
					D10	D50	D90
A-50 (SGA)	84,92	4,77	50,0	10	2,75	10,22	22,87
A-1	97,76	0,62	76,0	5	62,26	110,66	168,87
P-900	98,71	0,12	11,0	50	47,45	87,69	136,99
A-2	99,18	0,05	1,4	95	49,01	85,78	131,85
APC	99,64	0,03	1,2	95	56,72	96,67	143,69
A-50 (APC)	89,83	5,34	33,4	20	2,20	8,75	25,14

Table 2. Certain physical and chemical characteristics of the aluminas used in the studied compositions.

The results of suspension density and draining time in a Ford cup nº 4, obtained for the suspensions prepared with different aluminas, are shown in Figure 1-a and 1-b, respectively. It can be observed that increasing additions of AL 50 (APC) lead to a significant rise in viscosity, which is the limiting factor for the addition of this alumina, in addition to the proportions already used in the Original Composition.

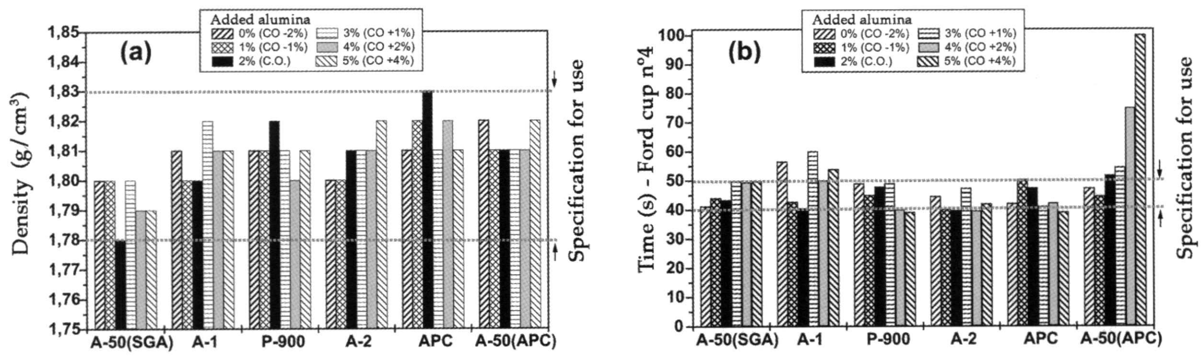

Figure 1. (a) Densities and (b) draining time of the ESO suspensions prepared with different aluminas.

In general, the engobes (ENP and ENI) had a clearly differentiated microstructural evolution depending on the type of alumina added. As an example, in Figure 2-a it can be observed that the water absorption of ENP, containing 8% by weight of A-1, approaches the zero value at 1180°C, while in the case of the A-2 and APC additions, this water absorption value is already reached close to 1160°C. The differentiation of the microstructural development as a consequence of the added alumina proportion was quite notable for all the studied engobes and glazes (ENP, ENI, ESO, EST and ESP), and displayed very similar behaviour. In the Figure 2-b, as an example of this typical behaviour in the glazes, it can be observed that fusion test specimen softening begins at lower temperatures when the alumina content introduced in the composition is smaller.

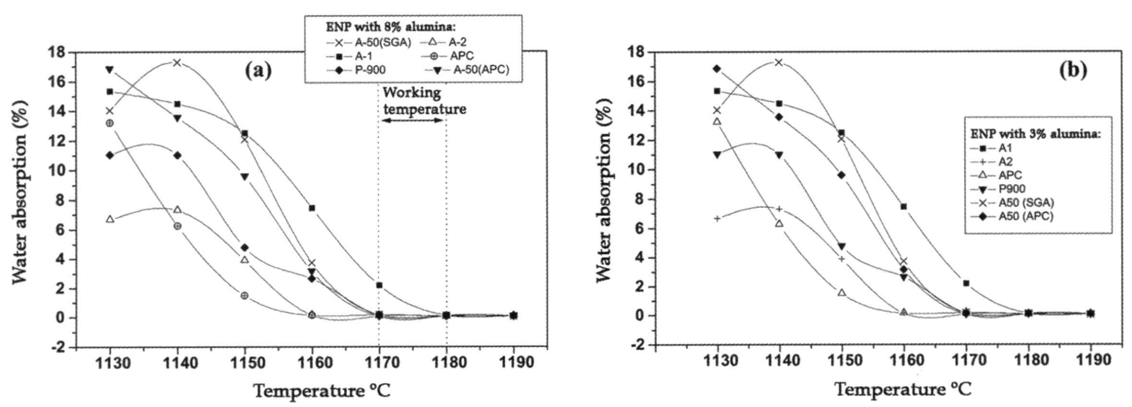

Figure 2. Behaviour based on firing temperature: (a) water absorption of ENP, containing 8% of different aluminas and (b) shrinkage of the height of ESO test specimens containing different alumina APC contents.

The results allowed establishing an overview of the acceptable amounts of alumina addition, as a function of the type of glaze or engobe, characteristics of the added alumina, working temperature and the desired technical and aesthetic characteristics of the finished product.

ACKNOWLEDGEMENT

The authors thank FAPESP, CNPq and FINEP by the resources and support received for the performance of this study.