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REUSE OF SPECIAL GLASS WASTE LIKE A FLUX IN MASSES FOR WHITE CERAMICS

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Abstract: Among the solid wastes discarded by the contemporary society, can be mentioned those called special glass wastes that, if disposed inadequately, put at risk the environment, since they contain toxic substances. Estimated that in Brazil are consumed about one hundred millions of fluorescent light bulbs a year. Of this total, 94% are destined to landfills and garbage dump, without any kind of treatment, contaminating the ground and the water with heavy metals. Faced with the environmental problems that this kind of vitreous waste can cause and taking into consideration the excessive use of nonrenewable raw materials on production of ceramics in Brazil, become of huge importance doing this study, that aims investigate the possibility to reuse of special glass wastes on production of masses to white ceramics, which will act like a flux. The research was made describing the waste and traditional raw materials (clay, quartz, kaolin and feldspar) through the following techniques: chemical analysis, particle size analysis, thermogravimetry (TG) and differential thermal analysis (DTA). Ceramics masses were formulated without glass waste and with glass waste substituting partially the feldspar on the proportions of 5% and 10%. Then, a rheological study of the obtained slip was made using the following tests: viscosity, density and pH. The results pointed to the possibility of use of this sort of waste like a flux in ceramics mass, contributing to the reduction of the energetic cost on production and to the decreasing of raw materials exploration.

INTRODUCTION

The accumulation of garbage in urban centers is, undoubtedly, one of the major environmental problems of today. The high costs of implementation and maintenance of collection systems and garbages's treatment, have often,taken to failure of government attempts to resolve this issue.

Among the vitreous waste generated, there the specials glass, which is originate from the disposal of fluorescent lamps, causing irreparable damage to humans and the environment, due to the high content of toxic contamination caused by the mercury (1).

Considering that Brazil sells about 100 million lamps per year and also knowing that the recycling industries of mercury lamps are responsible for control only about 6% of the stock of bulbs in the country, the problem of disposal of these wastes worsens greatly (2).

The reuse of waste glass, besides reducing the environmental impact, may contribute to the diversification of manufacturing and lower costs for the end of production, since it can act as flux (3).

Porto et al. (2011), sought to optimize the process of incorporating glassy residue in ceramic mass for stoneware sanitary partially substituting of feldspar and found that, the determination of flow curves and viscosity in the compositions of 4, 5 and 6% of residue on the samples studied, indicates be a rapid and efficient method for understanding the rheological behavior of ceramic slurries. Identifying also the ideal amount of deffloculant to be used, in order to achieve an optimal dispersion capable of giving satisfactory physical and mechanical properties of the ceramic.

This study aimed to characterize the residue of special glass and the traditional raw materials (clay, quartz, feldspar and kaolin) through techniques: chemical analysis, particle size analysis, thermogravimetry (TG) and differential thermal analysis (DTA).

MATERIALS AND METHODS

In this work it was used the following traditional raw materials: clay, originating from Alhandra /PB, quartz, feldspar and kaolin, from Junco do Seridó / PB, donated by the company COTEBRAS (Tecnoceramic Company of Brazil).The waste glass of fluorescent lamps were donated by an industry of Ceará, already benefited.

All raw materials were characterized by chemical analysis using classical techniques, instrumental and complexometric held in Mineral Analysis Laboratory of the Federal University of Campina Grande (UFCG).

The thermal behavior of these materials was studied by using the techniques of thermogravimetry (TG) and Differential Thermal Analysis (DTA). They carried on DTH equipment Model-60, SHIMADZU brand in Termoanalysis Laboratory from UFCG.

It was formulated masses reference standard with and without waste's glass of fluorescent lamps, replacing, partially, the feldspar in the proportions of 5% and 10% in an attempt to find a suitable percentage of residues that do not compromise the properties recommended to manufacture the whiteware. Then placed on agitation and determined the apparent viscosity using the Brookfield viscometer Model RBT, Spindel 4 in rotation 10, 20, 30 and 100 rpm. For preparation of the triaxial masses it was used the inorganic dispersant (Sodium Silicate), lent by Luzart / PE.

RESULTS AND DISCUSSION

Chemical analysis

Table 1 shows the chemical composition of raw materials used in this work.

Table 1 - Chemical composition of raw materials

RAW MATERIALS	CONCENTRATION IN WEIGHT (%)							
	SiO_2	Al_2O_3	K_2O	SO_3	CaO	Fe_2O_3	TiO_2	Na_2O
Clay	54,78	37,34	0,53	1,03	0,38	3,41	1,69	nd
Feldspar	69,33	19,49	8,93	1,38	0,36	0,09	nd	nd
Glass	64,95	4,31	1,10	1,12	5,26	0,10	nd	19,53
Kaolin	51,81	45,97	0,48	0,97	0,15	0,49	nd	nd
Quartz	96,07	2,30	0,08	1,52	nd	Nd	nd	nd

It is possible observes that the clay used presented low content of iron and titanium, with value of 3.41% and 1.69% respectively. Regarding the content of SiO2 showed 54.78%, very close to the composition of kaolin that was 51, 81%.

Regarding the quartz, it was observed a very considerable amount of SiO 2 of 96.07%. Already the feldspar it indicated percentages of 69.33% SiO2, 19.49% Al2O3 8.93% K2O, being regarded as potash feldspar. In turn, the special glass showed a percentage very characteristic of soda-lime glass, with values of 19.53% Na2 O and 5.26% CaO.

For all the samples, the content of impurities such as Fe2O3 and TiO2 are in negligible amounts, and thus, acceptable to the whiteware industry.

Thermal Behavior

Figure 1 shows the TG and DTG thermal analyzes on raw materials studied.

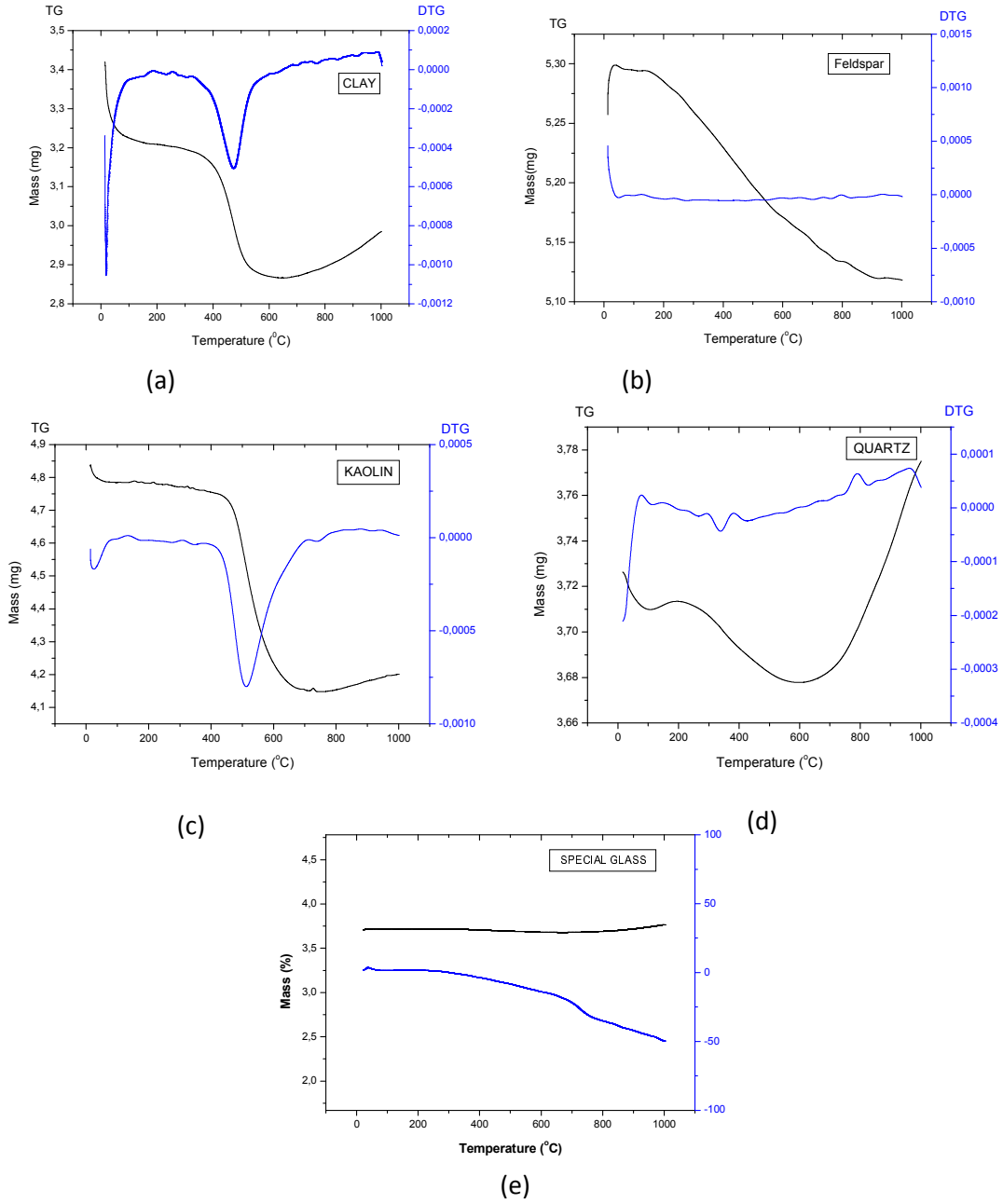

Fig. 1- TG and DTG thermal analyzes: (a) Clay; (b) Feldspar; (c) Kaolim; (d) Quartz ;(e) special glass

Analyzing the steps of decompositions in the TG curves of the clays, it is possible to see loss of free water in the range 25 to 125 °C (5.88%). Around 150 to 350 ºC can be observed loss of adsorbed water, while among 350 and 550 °C the clay showed loss related to decomposition of organic matter, approximately 8.8%. Around 990 °C there is a mass gain of 3.45%. The feldspar showed loss of total mass of 0.13 mg which represents approximately 2.47%. The glass doesn't showed significant weight loss, confirming the lack of carbonates, sulfates, clayminerals and organic matter, indicated in the chemical analysis . In turn, the kaolin showed, in the range of 50 to 350°C, loss of free and adsorbed water of 2.07%. Between 470 and 690 °C showed dehydroxylation. In the range of 780 to 1000 ° C, it was verified formation of metakaolinite, which becomes mullite, also referenced in the work of Souto et al. (2000), and verified by Cavalcanti (2010).. Finally, the quartz showed mass loss of about 1.31% in the range 25 to 600 °C corresponding to loss of water, combustion of organic matter and dehydroxylation and, from the 600 to 990 ºC showed sintering.

The figure 2 shows the DTA curves of raw materials, obtained at a heating rate of 10 °C / min. under an atmosphere of air.

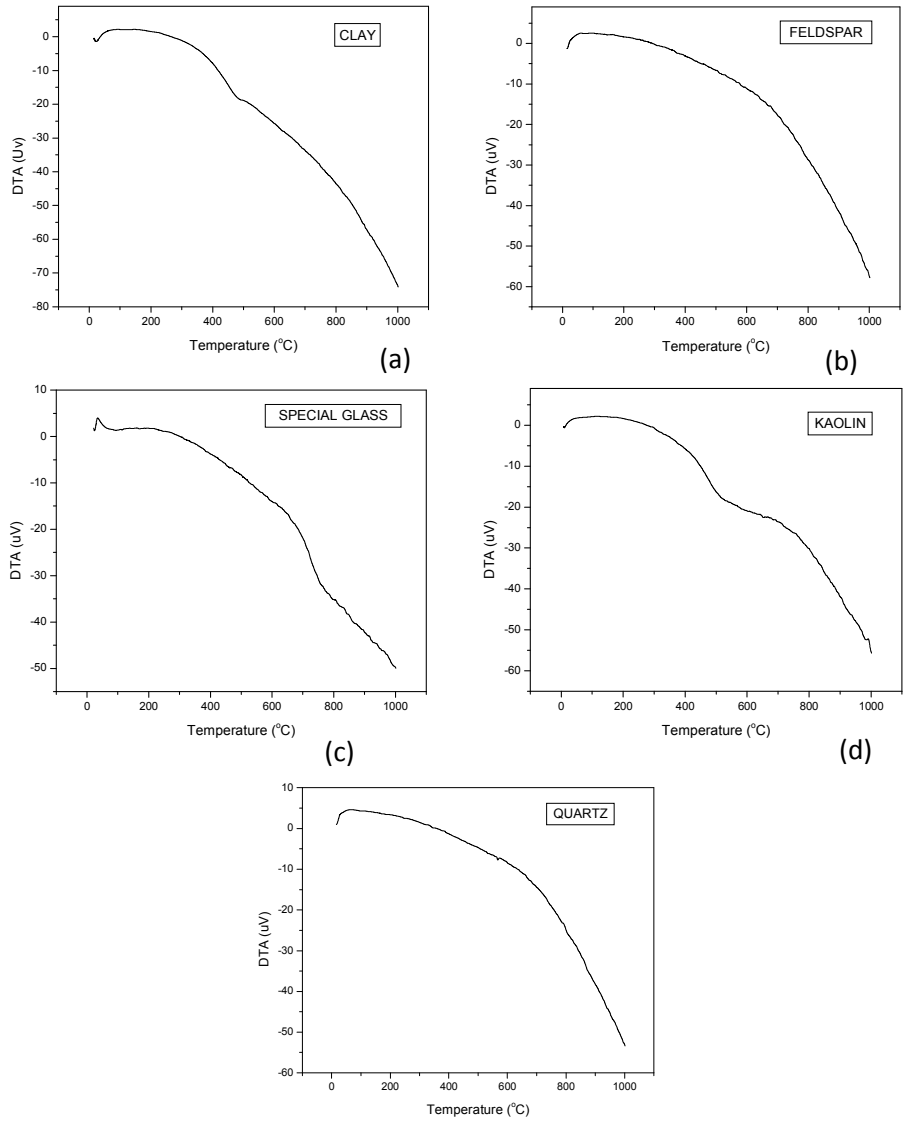

Fig. 2 - DTA curves of clay (a), feldspar (b), glass (c), kaolin (d) and quartz (e),obtained at a heating rate of 10 °C / min. under an atmosphere of air.

It is observed that clay, quartz and kaolin have confirmed events of low intensity. The curves of the kaolin and clay exhibit endothermic peaks in the temperatures approximately 470°C, 500°C respectively, characteristic of possible dehydroxylation. In the curve of the quartz is observed a endothermic event barely noticeable at 570°C, probably due to the polymorphic transformation of quartz α (alpha) in quartz β (beta) (5). Already curves feldspar and glass don't showed any significant event, proving the thermal stability of both substances.

Rheological study

Figure 3 represents the curves of deflocculation of the masses formulated without glass with 5% and 10% of glass lamp, only at the speed of 10 rpm, where they present the values of apparent viscosity as a function of the percentage of deflocculant (sodium silicate) used.

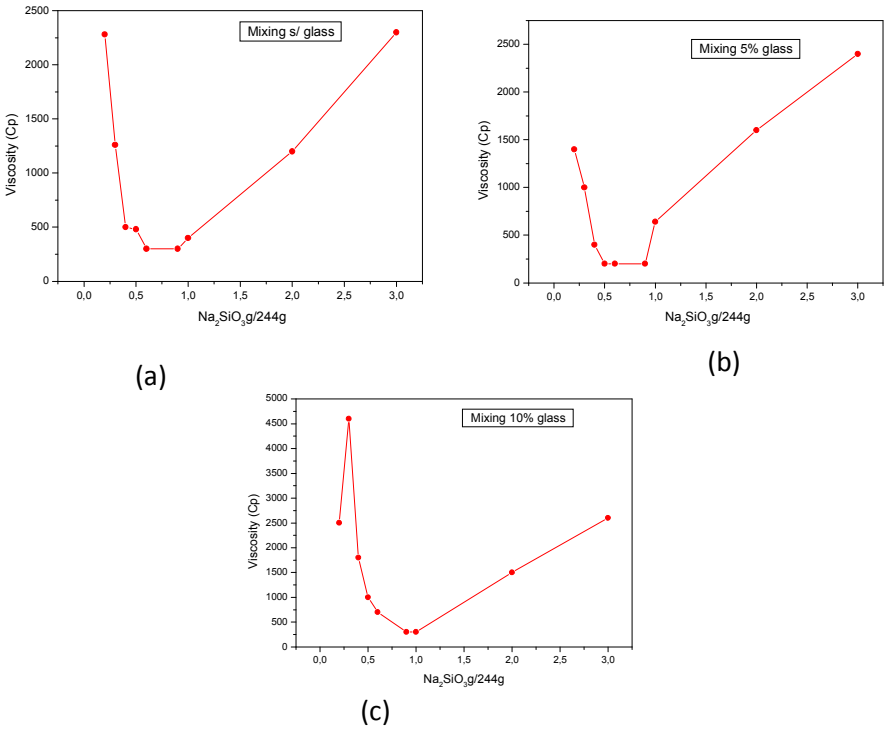

Fig. 3 - Deflocculation curves of mixtures: glassless (a), 5% glass (b) and 10% glass (c) at a speed of 10 rpm.

According to Santos (1992), through deflocculation curves, it is determined the optimum point of content of dispersant, noting "landmarks" as: starting point, minimum point and point beyond the minimum, for the beginning of change in viscosity as a function adding increasing deflocculant. Given the above, it was verified that the mixture without glass, showed optimum point, approximately between 0.2 and 0.6 ml, since the mixture with 5% glassy residue it was between 0.2 and 0.4, whereas the blend with 10% , there is the initial point 0.4 and point minimum 0.9, which corresponds to an optimum consumption of dispersant of 0.4 ml, 0.3 ml and 0.65 ml, respectively.

CONCLUSIONS

• Through the results of chemical and mineralogical composition it was found that the raw materials that was analyzed have high content of kaolinite, and low content of impurities such as Fe_2O_3 and TiO_2, thus indicating great potential for use in ceramic white.
• About the thermal behavior could be concluded that the samples presents adequate and favorable characteristics, due to the small mass losses and events with peaks of low intensity, proving the thermal stability of these, especially the residue of special glass for partial replacement of feldspar .
• Finally, the rheological study demonstrated the possibility of formulating the mixtures studied with low consumption, to obtain a slurry with proper fluidity, when showed small differences between the optimal points of the sample without waste, with the sample with partial substitution of feldspar. In the substitution of 5% of glass, was observed lower consumption of deflocculant relative to the mixture without residue, with a decrease of the reference points identified.

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