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STUDYING THE EFFECT OF A CHANGE IN ALUMINUM OXIDE CONTENT ON THE PHYSICOCHEMICAL PROPERTIES OF DOLOMITE OPACIFIED GLAZES

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13. ABSTRACT

Physicochem. properties were studied with 13 compns. in which Al_2O_3 content was changed from 4 to 20% by proportional changes in other components of the initial glaze. The viscosity and refractory properties of dolomitic opacified glazes increased with increased Al_2O_3 content during formation of frit. With increase in Al_2O_3 content up to 14%, the viscosity of crystd. sample increases gradually from 3.36 to 26.42 × 10^{10} poises. The further increase in Al_2O_3 content resulted in a sharp increase of viscosity to 81.36 × 10^{10} poises. The temp. of softening, detd. simultaneously with the coeff. of thermal expansion, increased noticeably (680-790°) with increased content of Al_2O_3. The exptl. coeffs. of thermal expansion of crystd. samples contg. 8-10% of Al_2O_3 at 400° (61.5-59.0 × 10^{-7}) were very similar to coeffs. calcd. from the chem. compn. according to the additive factors. The coeffs. of diffusion reflection (whiteness) of glazed samples after glost firing increased to 77.7-80% with increase in Al_2O_3 content from 4 to 6.5%. It decreased to 72.9% with further increase in Al_2O_3 content. The microhardness of samples increased with increase of Al_2O_3 up to 14% ([illegible] kg./cm.^{2}) and then begins to decrease ≈604 kg./m.^{2}

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Dolomite Opacified Glazes						

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STUDYING THE EFFECT OF A CHANGE IN ALUMINUM OXIDE CONTENT ON THE PHYSICOCHEMICAL PROPERTIES OF DOLOMITE OPACIFIED GLAZES

Kh. Yunusov, I. Azimov, S. Tashkhodzhayev, and N. A. Parpiyev

The effect of aluminum oxide on the quality of glasses and glazes is known [1-4]. However, its effect on the physicochemical properties of glazes in which the thinly dispersed crystalline phases of silicon compounds of alkaline-earth metals are formed has not been studied.

Thirteen compounds in which the Al_2O_3 content varied from 4 to 20 wt. % due to the proportional change in the remaining composite components of the original glaze were studied on the basis of the original glaze X-0 [5].

It was visually established that with an increase in Al_2O_3 content the viscosity and refractoriness of dolomite opacified glazes increases during the frit boiling. During this the crucibles are not corroded with a change in the composition. With an increase in Al_2O_3 content the start (980-1000°C) and the end (1050-1100°C) of the melting point, and also the temperature of the start of spreading (1160-1210°C) of glaze increase insignificantly [5].

By increasing the Al_2O_3 content to 14% the viscosity of crystallized samples increases moderately ($3.36-26.42 \times 10^{10}$ poise) and with further increase in Al_2O_3 it increases sharply to 81.36×10^{10} poise.

The softening temperature determined simultaneously with the thermal expansion coefficient (TEC) [HTP] increases considerably (680-790°C) with an increase in the Al_2O_3 content.

The experimental TEC of the crystallized samples containing 8-10 wt. % of Al_2O_3 at 400°C ($61.5-59.0 \times 10^{-7}$) are very close in their chemical composition to those calculated according to their additive factors of A. A. Appen ($60.74-59.75 \times 10^{-7}$). With an increase or decrease in the Al_2O_3 content the experimental TEC ($40-65.5 \times 10^{-7}$) deviate from those calculated ($54.25-62.32 \times 10^{-7}$). The decrease in TEC is insignificant ($73.6-63.8 \times 10^{-7}$) at the softening temperature of the samples with increase in Al_2O_3 content, for example at 400°C.

The coefficient of diffusion reflection (whiteness) of glazed samples after glost firing increases to (77.7-80.0%) with a change in Al_2O_3 content from 4 to 6.5 wt. % and with further increase in Al_2O_3 content, it decreases to 72.9%. In this case, the glost of the samples changes along the flat curve and the maximum is observed with the Al_2O_3 content of 9% (11.1 is the number of glost). With increase of Al_2O_3 in the composition the maximum deviation in the reflection coefficients (degree of yellowness) at wavelengths of 400-750 nm increases considerably (5-26.5).

With an increase in Al_2O_3 content up to 14 wt. %, the microhardness of samples increases to (506-652 kg/mm^2) and then begins to decrease (to 604 kg/mm^2).

All studied compounds regardless of the amount of Al_2O_3 and the presence of the crystalline phase of the opacifier are chemically stable in acids and alkalies (97.72-99.96%).

The X-ray phase analysis of the glazes crystallized by 20-hour holding at 1050°C has shown that by increasing the Al_2O_3 content to 14 wt. % a predominately crystalline phase, diopside $CaO \cdot MgO \cdot 2SiO_2$, is precipitated (characteristic lines of the interlayer distances are 2.97; 2.51; 1.619; 1.415), and with a further increase in their Al_2O_3 content up to 20% a mineral mixture, diopside and anorthite $Ca\{Al_2Si_2O_8\}$ [6] (characteristic lines of the interlayer distances are 3.16; 2.49; 2.12; 1.753), is precipitated, which is confirmed by crystallooptic observation under a microscope.

The refractive index of the crystalline phase was established only for the compounds containing up to 14% of Al_2O_3 where the crystals of the diopside mineral were present (N_p = 1.667; Ng = 1.698). Beyond this limit, with the exception of dioxide, new compounds appeared which prevented us from accurately establishing the refractive index of the crystalline phase of glaze.

As a result of the visual examination of the samples after they have been fired in the gradient furnace at the temperature range of 600-1200°C, it was established that the temperatures at which the samples begin to bake (640-800°C) and the glost begins to appear (755-830°C), and also of the start (820-890°C) and the end (1070-1200°C) of the firing period increase evenly with an increase in Al_2O_3 content, which is additional confirmation of the fusibility and softening temperature of the compounds.

The visual examination of the glazed samples after the glost firing (1050°C) indicates that the change in the content of Al_2O_3 in the compound does not significantly influence the quality of glazed coatings with the exception of the degree of opacification. The latter has a good rating when the Al_2O_3 content is within the 6-12 wt. % range.

Conclusions

1. Up to certain limits (up to 14 wt. %) the Al_2O_3 in a glaze compound is only a component forming glass. In addition to the crystalline opacified glazed phase of the diopside, a new mineral, anorthite, is precipitated when the Al_2O_3 content is increased.

2. In order to obtain the faience glazes opacified with the diopside crystals at a temperature of glost firing of 1050°C and having high physicochemical properties, the maximum Al_2O_3 content can be in the range of 6-10 wt. %.

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