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The Physico–Chemical Analysis of Quartz Sand of "Khiva" Deposit

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ABSTRACT

In the article, the quartz sand of the "Khiva" deposit was comprehensively researched based on chemical, X–ray phase, IR spectroscopic analyses. According to the results of the analysis, the content of quartz sand is up to 86% α–quartz, as well as a small amount of feldspar, chlorite and calcite minerals. Based on the results of the research, it was determined that enrichment of these sands is required to obtain colorless and transparent glass enamel frits from this raw material.

KEYWORDS: quartz, feldspar, minerals, concentrate, enrichment, X–ray phase analysis, IR spectroscopy, physico–chemical analysis, "Khiva" deposit, raw material.

INTRODUCTION

Despite the large number of siliceous raw materials, which are considered important for the production of silicate materials, there are few mines that use them without enrichment for the production of glass and glass products [1]. The quality of glass and ceramic products depends on the chemical and mineralogical properties of the raw materials used [2]. One of the main problems of processing silicate materials is the high consumption of energy in the processing of raw materials.

Development of scientific research on a comprehensive study of the characteristics of natural mineral raw materials and secondary resources, development and widespread use of innovative technologies for the enrichment of local raw materials, finding analogues or replacing main raw materials with other components in order to obtain high–quality products, as well as reducing costs for fuel, auxiliary materials and thereby reducing the cost of finished products will help strengthen the economy [3].

This article describes the research on the use of quartz sands from the "Khiva" deposit, located in Khorezm province of the Republic of Uzbekistan, in the silicate industry.

MATERIAL AND METHODS

The quartz sands of the "Khiva" deposit, located in the Khorezm region, were studied as a research object.

The granulometric, chemical, chemical–mineralogical composition of raw materials was determined by physical–chemical analysis [5–7]. An average sample was taken for quantitative sand analysis. Determination of the total granulometric composition of the selected samples was carried out based on the requirements of GOST–22552.0. For this, we used sieves of size 01 and 08 that meet the requirements of GOST-6613, a laboratory technical scale that meets the requirements of GOST–24104 with an accuracy of 0.01 g, a mechanical shaker, and a drying cabinet with a thermoregulator that provides a temperature of 105–110°C. First, the samples were dried at a temperature of 105–110°C to a constant mass, and 3 samples weighing 100 g were prepared and the samples were sieved in a mechanical shaker for 10 minutes. The finished grain samples were studied by physico-chemical analysis.

RESULTS AND DISCUSSIONS

"Khiva" mine, in the upper part of the earth's surface, the depth is from 2.0–3.0 m to 20.7 m, in some places the height of the piles reaches 10–25 m. Mineral deposits in the mine belong to the group of eolian sands and are located in the form of mine plast. The color of the sand grains is light yellow and it belongs to quartz sand according to its composition [4]. The content of quartz mineral is 80.0–95.0%, feldspar is up to 5%, mica content is 01–0.4%, other minerals are up to 5.0–10.0%. The balance reserve of the mine is 1197 m 3 or more than 2 million tons according to category A+B+S1.

The sands suitable for glass production are evaluated according to the requirements of state standards in terms of

grain size, and it is indicated that the size of their main part is 0.1–0.5 mm. Samples were taken from the surface, 3, 5, 7 and 10 meter depths of the area selected for the quarry. In the given data, samples 1–3 were taken from the surface, samples 4–5 were taken from a depth of 3 meters, samples 6–7 were taken from a depth of 7 meters, and samples 8-9 were taken from an outcrop of 10 meters.

The results of the granulometric analysis determined according to the results of the study are presented in Table 1 below.

Table 1. The granulometric analysis of raw sand samples taken from the deposit

Classes, mm	Amount of granulometric content of samples, %							
	1	2	3	4	5	6	7	8
+0,8	1,1	1,0	1,3	2,0	0,8	1,6	1,5	1,1
–0,8+0,63	0,2	0,1	0,5	0,4	0,2	0,6	0,2	0,6
–0,63+0,4	0,3	0,4	0,2	0,7	0,4	0,5	0,2	0,4
–0,4+0,315	0,5	0,6	0,8	0,6	0,6	0,4	0,9	0,4
–0,315+0,20	15,4	11,6	16,8	14,0	16,2	14,5	12,0	12,7
–0,20+0,16	26,9	30,2	29,9	26,6	29,6	30,2	31,5	23,5
–0,16+0,10	44,3	45,4	39,1	42,1	41,4	42,3	43,1	49,9
–0,10+0,063	5,7	5,8	6,2	8,6	7,8	7,2	7,3	7,7
– 0,063	4,6	4,9	5,0	5,0	3,0	3,1	3,5	3,7
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

According to the table, the initial samples of quartz–feldspar sands of the Khiva mine do not meet the requirements for obtaining glass in terms of granulometry. In all the samples, the amount of fractions smaller than 0.1 mm was more than 10%, and fractions larger than +0.8 mm were present in the amount of 0.8–2.0%. Raw material samples were chemically analyzed based on established normative documents (Table 2).

Table 2. The chemical composition quartz sands of "Khiva" deposit

Samples	Amount of oxides, mass %									
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	TiO_2	SO_3	LOI
1	86.54	2.78	1.60	1.50	0.32	1.72	1.91	0.02	0.50	3.11
2	86.29	2.61	1.42	1.16	0.10	1.26	2.11	0.07	0.82	4.16
3	86.17	2.73	0.95	1.76	0.28	1.25	1.87	0.10	0.66	4.23
4	87.76	1.90	1.27	1.67	0.22	1.21	1.95	0.05	0.21	3.76
5	85.60	3.15	1.25	1.08	0.23	1.23	1.76	0.03	0.15	5.52
6	82.14	3.32	1.20	1.17	0.19	1.26	1.87	0.01	0.09	8.76
7	86.30	2.65	1.17	1.13	0.29	1.28	1.71	0.07	–	5.39
8	87.76	2.00	1.20	1.56	0.14	1.20	1.62	0. 01	–	4.51
Average	86.06	2.64	1.25	1.37	0.22	1.30	1.85	0.04	0.4	4.93

For the use of these raw materials in research, its average content in % is SiO_2–86.06; Al_2O_3–2.64; Fe_2O_3–1.37; CaO–1.37; MgO–0.22; K_2O–1.30; Na_2O–1.85; TiO_2–0.04; SO_3–0.4 was assumed to be 0.4 and the mass loss on combustion was 4.93.

In order to determine the mineralogical composition of raw samples, X–ray phase analyzes were carried out (Figure 1) [8–10].

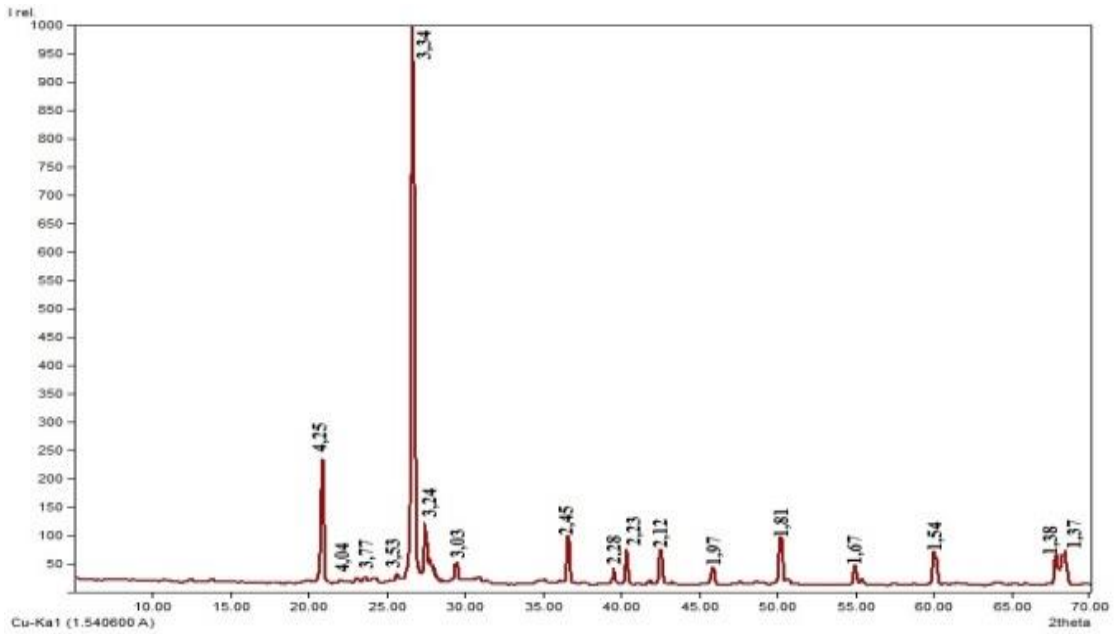

Figure 1. X–ray of quartz sand sample

Pentgenogpamma has the strongest peak intensity in three peaks, i.e. 3.24 (I=18%); the 3.34 (I=100 %) and 4.25 (I=22 %) d,Å peaks at these wavelengths are characteristic of α–quartz. Also 3.03; 2.57; it was found that the peaks of 2.28 d,Å are characteristic of feldspar, 3.57 d,Å of hydromica, and biotite was shown in peaks of 3.18 d,Å. Chlorites in the sample are 10.51; 7.10 and 6.47 d,Å peaks, 3.85; 3.03; calcite minerals were detected at 2.89 and 2.28 d,Å peaks. Iron compounds such as hematite in the composition 3.66; 2.28 and 1.45 d,Å peaks were observed. All peaks with low residual intensity are characteristic of α–quartz.

From the results of the analysis, we can see that the OH group in the raw material of the sample appeared in valence vibrations in the region of 3368 cm^{-1}. No deformation fluctuations were observed in this area, which indicates the absence of adsorbed water in the sample analyses (Figure 2).

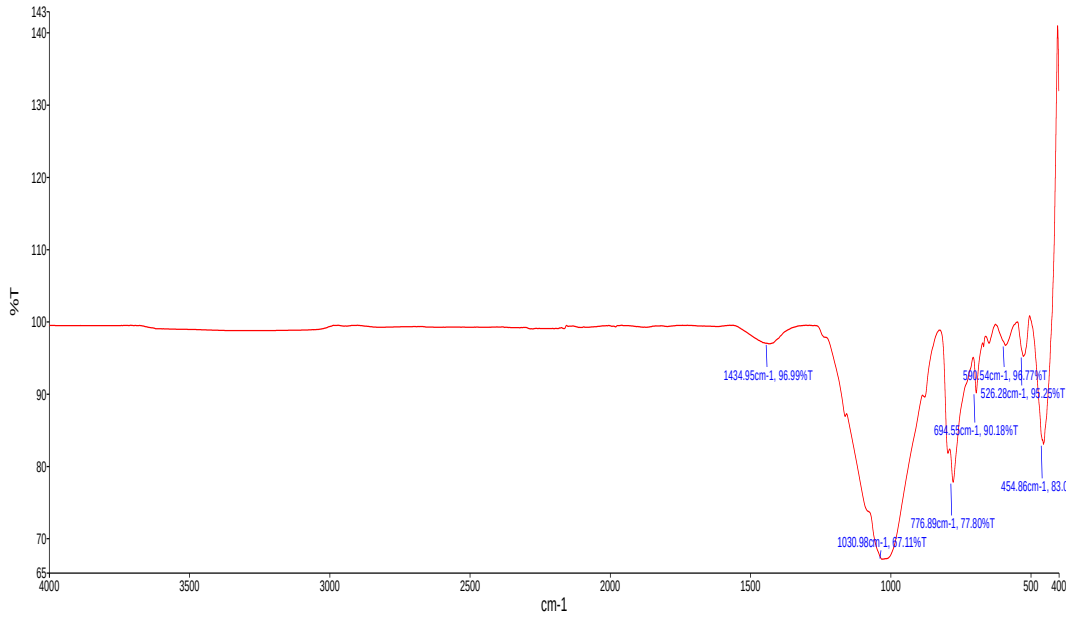

Figure 2. IR spectroscopy analysis of quartz sand sample

The non–bridged connection of the Si–O bond was observed in the 876 cm^{-1} and 1007 cm^{-1} valence vibrational regions. Si–O–Si bridge bonds were observed in deformation vibrations in the 459 cm^{-1}, 777 cm^{-1} and 694 cm^{-1} regions. Bridging bonds of Si–O–Al bonds were manifested in vibrations in the region of 1434 cm^{-1}.

Based on preliminary studies, it was determined that enrichment of these sands is required to obtain colorless and transparent glass enamel frits from this raw material.

CONCLUSION

The quartz sand of the "Khiva" mine was subjected to a comprehensive physical and chemical analysis. According to the results of the analysis, it was found that the composition of quartz stone consists of up to 86% α–quartz, as well as a small amount of feldspar, chlorite and calcite minerals. Based on the research results, it was determined that enrichment of these sands is required to obtain colorless and transparent glass enamel frits from this raw material.

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