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Influence of Iron–Containing Gas Cleaning Dust Waste on the Technological Properties of Ceramic Masses

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ABSTRACT

When studying a number of series of ceramic experimental compositions, we found that when using a steel–smelting shop of “Uzmetkombinat” JSC Uzbekistan–gas cleaning dust, the optimal content is an additive in an amount of 5 to 20 mass.%.

KEYWORDS: Angren secondary kaolin, Angren variegated clay, gas cleaning dust, melting temperature, firing temperature, ternary system, ceramic mass, burning, shrinkage, water absorption.

INTRODUCTION

It is known that [1–3] various solid materials have different melting points, which depend on its material composition, structure, or other physicochemical properties. Therefore, it is necessary to determine the melting temperature ceramic materials of each component of the raw charge separately and of the charge itself together with all components.

MATERIALS AND METHODS

For research, we tested the constituent components of the ceramic mass – gray kaolin Angren, variegated clay Angren and steel–smelting “gas cleaning dust” of “Uzmetkombinat” JSC. We have determined the melting points of each initial component separately and of all the tested compositions of the ceramic mass with different variations of the components.

RESULTS AND DISCUSSIONS

Determination of the temperature of the beginning and end of melting of the components used for the preparation of prototype samples of the ceramic mass showed (Table 1) that the lowest value of the melting temperature at 1200 ° C is observed in samples containing “gas cleaning dust” of Uzmetkombinat JSC, and the highest temperature value melting point of 1490 °C is observed in samples of Angren clays.

Table 1: Name and melting temperature of the components used in the ceramic mass

Sample name	Melting temperature, ºC	
	start	finish
Angren secondary unenriched kaolin	1380	1460
Angren variegated clay	1400	1490
Gas cleaning dust JSC “Uzmetkombinat”	1200	1235

To determine the melting temperature of the prepared compositions of ceramic masses with various variations of components, we compiled a triple system: “Angren secondary kaolin–Angren variegated clay–Gas cleaning dust” (Figure 1).

To compile various options for the recipe composition of ceramic masses and their technological implementation, scientific approaches to chemical and mineralogical characteristics were used. The area of the studied compositions based on the triple system “kaolin–clay–gas cleaning dust” is shown in Figure 1.

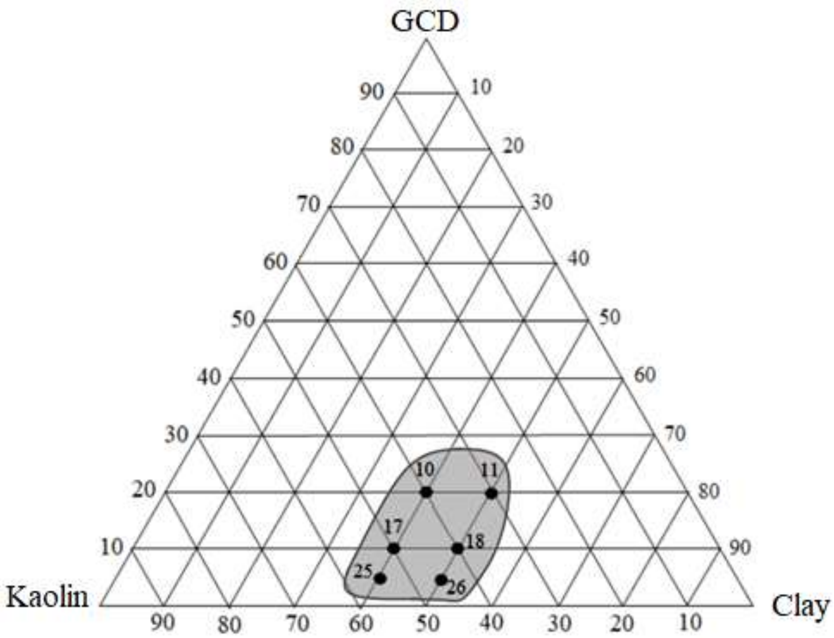

Fig. 1. The area of the studied and optimal compositions of the ternary system "kaolin–clay–gas cleaning dust"

As can be seen from the triple diagram, the optimal compositions of ceramic masses lie near the top of the triangle, where the maximum clay and kaoline content is located.

Based on the above data, it should be noted that for the development of the composition and production of ceramic materials for various purposes, aluminosilicate minerals in the form of kaolins, refractory and fusible clays, as well as smooth–forming, mineral–forming, plasticizing and other various additives are mainly used as initial raw materials.

At the same time, it should be noted that in order to stabilize the structure of crystalline phases and reduce the sintering temperature of the kaolin–clay mass, dust from the gas cleaning of metallurgical production was added as a smooth–forming component. The component and chemical compositions of the samples based on the "kaolin–clay–gas cleaning dust" composition are given in Tables 2 and 3, respectively.

Table 2: Compositions of experimental samples of ceramic masses based on the composition "kaolin–clay–gas cleaning dust"

Name of samples	Components, mass.%		
	Secondary kaolin of Angren	Clay of Angren	Gas cleaning dust
KCG–10	40	40	20
KCG–11	30	50	20
KCG–17	50	40	10
KCG–18	40	50	10
KCG–25	55	40	5
KCG–26	45	50	5

Calculation of the chemical composition of prototypes of ceramic masses based on the material composition of the used raw materials was carried out according to the method of G.N. Maslennikova [4].

Table 3: Chemical composition of experimental samples of ceramic masses using gas cleaning dust

Sample indices	Mass content of oxides, mass.%									
	SiO_2	Al_2O_3	Fe_2O_3 general	TiO_2	MgO	CaO	Na_2O	K_2O	MnO	ZnO
KCG–10	55,04	20,07	14,25	0,34	0,98	6,23	0,62	0,75	0,63	1,10
KCG–11	53,48	20,96	14,79	0,34	1,09	6,16	0,67	0,78	0,63	1,10
KCG–17	61,76	21,94	8,81	0,38	0,82	3,93	0,67	0,83	0,31	0,55

KCG–18	60,20	22,83	9,35	0,38	0,94	3,86	0,72	0,86	0,31	0,55
KCG–25	65,12	22,88	6,09	0,40	0,75	2,78	0,69	0,87	0,16	0,27
KCG–26	63,56	23,76	6,63	0,40	0,86	2,71	0,75	0,90	0,16	0,27

In addition, gas cleaning dust contributes to the complete sintering of the obtained ceramic masses, due to an increase in the content of the liquid phase between the Minerals of kaolin and clay. As a result, kaolin and clay enter into a chemical reaction already at low temperatures and a well–sintered ceramic mass acquires maximum density and strength (table 4)

Table 4: Influence of gas cleaning dust on firing temperatures and technological properties of ceramic mass

Sample name	Firing temperature, in °C and property indicators, %							
	950		1000		1050		1100	
	shrin–kage	water absorp–tion	shrin–kage	water absorp–tion	shrin–kage	water absorp–tion	shrin–kage	water absorp–tion
KCG–10	1,0	16,2	2,2	14,2	5,0	10,7	7,4	8,4
KCG–11	1,2	15,8	2,5	13,7	5,4	10,1	7,7	8,0
KCG–17	1,4	14,9	2,8	13,1	5,7	9,7	8,0	7,6
KCG–18	1,5	14,4	2,0	12,8	6,0	9,2	8,3	7,3
KCG–25	1,3	15,3	2,6	13,4	5,5	9,9	7,8	7,8
KCG–26	1,7	13,2	2,6	12,6	6,3	8,6	8,8	6,9

It is known [5,6] that special attention is paid to the issue of improving the properties of the ceramic mass for facing plates, by using various additives as flux formers. In this regard, in order to optimize the composition of ceramic masses and improve the technology of their low–temperature production, a number of experimental compositions based on kaolin, clay and gas cleaning dust have been developed.

To determine the change in the melting temperature and the effect of the plan–forming additive, we compiled five mixtures of samples with various additions of iron–containing gas cleaning dust of “Uzmetkombinat” JSC and tested the beginning and end of melting of the samples in a high–temperature silicate furnace (table 5) [7].

Table 5: Component composition of the experimental compositions of the masses

Name of raw materials components	Designation of samples of the composition of the experimental mixture				
	PG–0	PG–1	PG–2	PG–3	PG–4
Angren secondary unenriched kaoline	50	45	45	40	20
Angren variegated clay	50	50	45	45	60
Gas cleaning dust JSC “Uzmetkombinat”	–	5	10	15	20

The prepared mixtures of compositions based on the indicated raw components were mixed in a laboratory ball mill with uralite balls and trihedral samples were molded in the form of a cone to determine the beginning and end of melting of the samples, and tile samples of 3×3×1 mm in size were molded to determine air and thermal shrinkage, water absorption, open and closed pores and other physical and mechanical characteristics.

Determination of the temperature of the beginning and end of melting of the tested compositions showed that an increase in the amount of gas cleaning dust (Table 5) in the ceramic mass proportionally affects the decrease in the melting temperature of the samples (Figure 2).

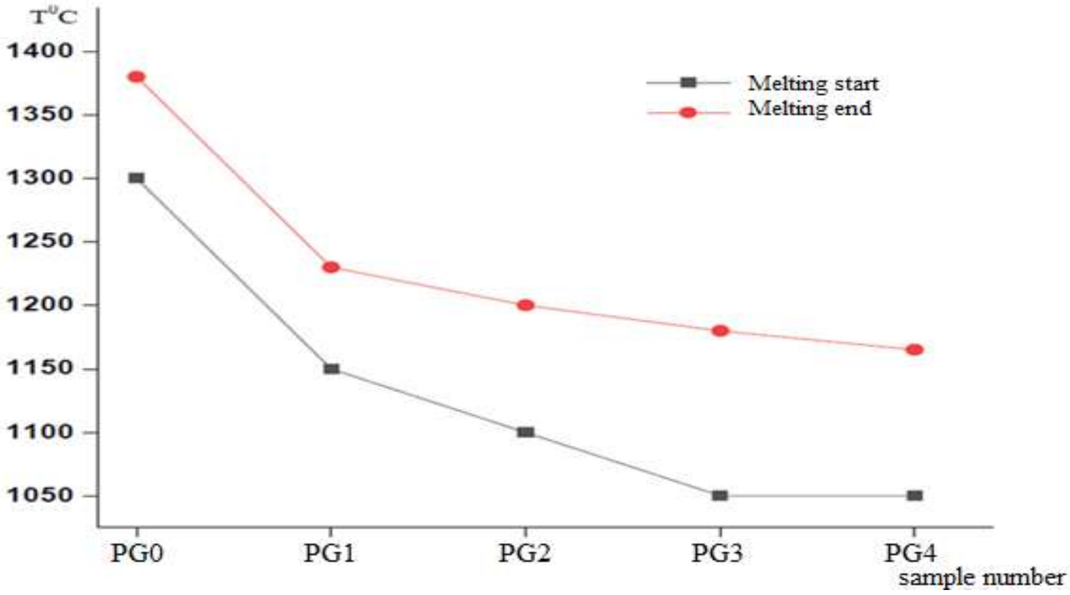

Fig. 2. Influence of the amount of dust and gas cleaning on the melting point of the ceramic mass

From Figure 2 and according to the data in Table 5, it was found that with an increase in the amount of iron–containing "gas cleaning dust" of "Uzmetkombinat" JSC in the ceramic mixture, the melting temperature of ceramic charge samples significantly decreases. However, with the largest amount of a smooth-forming additive, in the form of iron–containing gas cleaning dust, it negatively affects the technological properties of the sintered ceramic mass [4].

It should be noted that the introduction of gas cleaning dust in an amount of more than 20 mass.%, the value of linear shrinkage sharply increases, the samples are bent, and a glass phase and melt appear.

Determination of water absorption and shrinkage values show (Table 4) that the addition of iron–containing gas cleaning dust significantly reduces the temperature of the beginning and end of the float of the mass, however, a large amount of its addition leads to high shrinkage of ceramic prototypes and their curvature. As a result, the water absorption of ceramic samples sharply decreases, which does not meet the technological requirements. According to the requirements of GOST 13996–93 and GOST 6141–91, water absorption for internal linings should be W = 2–16% and for external 4–12%, and shrinkage of samples should not exceed 5% [8, 9].

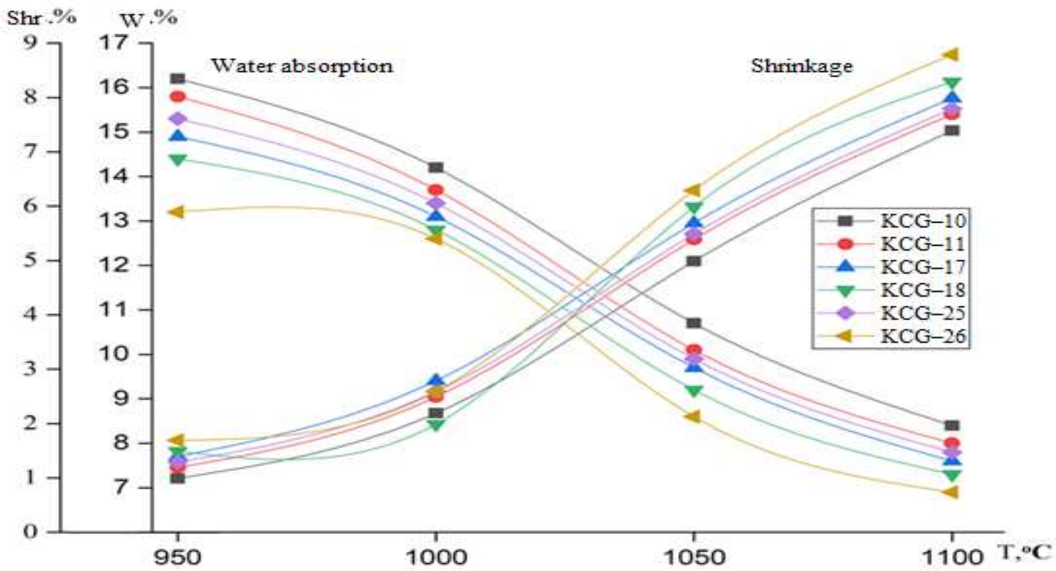

Fig. 3. Influence of iron–containing dust of gas cleaning JSC "Uzmetkombinat" on the main technological characteristics of the ceramic mass

It should also be noted that very low shrinkage rates and high water absorption rates are signs of an insufficient degree of the sintering process, which significantly affect the physical and technical properties of ceramic materials. Therefore, we have chosen the optimal compositions from a series of experimental tests (table 5.) PG1 and PG4 compositions, where both water absorption and shrinkage limit meet the requirements according to GOST 13996–93 and GOST 6141–91.

CONCLUSIONS

Thus, a number of component compositions of the ceramic mass based on Angren kaolin and clay have been developed, using metallurgical waste–dust from the gas cleaning of the steel–smelting shop of Uzmetkombinat JSC. The study revealed that the optimal content is the addition of gas cleaning dust in an amount of 5 to 20 wt.%. It has been established that when an additive of waste gas cleaning dust is introduced into the ceramic mass in an amount above 20 wt.%, the technological properties of the ceramic mass deteriorate.

REFERENCES

1. Tolkacheva A.S., Pavlova I.A. Technology of ceramics for materials of the electronic industry. Part 1. Yekaterinburg, Ural University Press. 2019. – p. 124.
2. Dyatlova E.M., Klimosh Yu.A. Chemical technology of ceramics and refractories. Part 1. Chemical technology of inorganic substances, materials and products. Minsk, BSTU. 2014. – p. 224.
3. Avvakumov E.G., Lepezin G.G., Seretkin Yu.V., Vinokurova O.B. Patent RU No. 2463275, Publ. 10.10.2012. Influence of the nature of the aluminum-containing compound and mechanical activation of mixtures with kaolin on the synthesis of mullite.
4. Maslennikova G.N., Kharitonov F.Ya., Dubov I.V. Calculations in technology of ceramics. Moscow: Stroyizdat. 1984. – p. 200.
5. Vakalova T.V., Khabas T.A., Reva I.B. Workshop on the basics of technology of refractory non–metallic and silicate materials. Publishing house Tomsk PU, 2013. – p. 176.
6. Tairov S.S., Kadyrova Z.R., Sabirov B.T. Wagging of the waste "Gas cleaning dust" on the physical and technical indicators of ceramic samples for ceramic tiles. Mat. International scientific symposium named after Academician M.A. Usova of students and young scientists "Problems of geology and development of subsoil", Tomsk, Tomsk State Pedagogical University, Volume II. 2020. – p. 376–377.
7. Tairov S.S., Sabirov B.T., Kadyrova Z.R., Khomidov F.G. Use of dust of gas cleaning of metallurgical production in the composition of ceramic mass for facing tiles. European Science Review, 2018. – p. 269–272.
8. GOST 13996–93. Interstate standard, Facade ceramic tiles and carpets of them, specifications, Facade ceramic tiles and carpets of them. Specifications, OKSTU 5752, Introduction date, 1995.
9. GOST 6141–91. Glazed ceramic tiles for lining of the walls, specifications, glazed ceramic tiles for lining of the walls specifications, OKP 575210, 1991.