International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 05 Issue 12 December 2022
DOI: 10.47191/ijcsrr/V5-i12-15, Impact Factor: 5.995
IJCSRR @ 2022
www.ijcsrr.org

Use of Industrial Waste in the Development of Ceramic Mass Compositions

Tairov S.S.[1], Kadyrova Z.R.[2]
[1] PhD, Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan.
[2] Doctor of Chemical Sciences, Professor, Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan.

ABSTRACT: The compositions of ceramic masses for facing slabs based on Angren secondary kaolin and clay were developed, using metallurgical waste–iron–containing dust from the gas cleaning of "Uzmetkombinat" JSC and sandy waste from the Toytepe fluorite enrichment plant. With the help of differential thermal and X–ray phase analysis, the chemical–mineralogical compositions, exothermic and endothermic effects of the used components of ceramic masses were determined during their heat treatment. Thus, the suitability of using these wastes for the development of the composition of ceramic masses has been established.

KEYWORDS: Angren kaolin, Angren clay, gas cleaning dust (GCD), ceramic mass, chemical composition, differential thermal, fluorite flotation enrichment (FFE), temperature, X–ray.

INTRODUCTION

In the world, great importance is attached to the issues of saving fuel and energy resources, through the rational use of mineral raw materials and secondary materials in the production of ceramic products. The main properties of ceramic products depend on the sintering process of aluminosilicate raw materials. Since, the most important physical and chemical processes that ensure the formation of a strong and characteristic structure of a ceramic shard occur precisely during their sintering. Sintering is a multi–factorial and complex process that fundamentally determines the functional and operational properties of the fired ceramic shard. Especially, in the absence of suitable raw materials in the production of facing tiles, in the technological process of which automatic or program–controlled conveyor lines are used, when choosing raw materials, the constancy of their chemical composition and the stability of their physico–chemical and technological properties come to the fore. At the same time, it should be noted that all over the world special attention is paid to the study of the processes of low–temperature sintering of aluminosilicate raw materials, the use of secondary resources in the development of compositions and technological regimes for the production of ceramic materials is an urgent task.

At present, due to the reduction of stocks of traditional ceramic raw materials, the problem of using industrial waste in their production is becoming more and more urgent. Some of them are raw materials that do not require additional processing. Most industrial wastes are characterized by significant fluctuations in chemical and mineral composition. Insufficient knowledge of the raw material itself and its behavior in masses during heat treatment limits its use in production. All this leads to the need for additional research to determine the possibility of using secondary raw materials for the production of various types of ceramic materials [1–3].

Ceramic wall materials occupy a leading position in the construction market due to their physical and mechanical, thermo physical properties, durability, environmental friendliness and architectural expressiveness [4].

MATERIALS AND METHODS

In the production of wall ceramic materials, the quality of clay raw materials is the most important factor determining the technological parameters of production and the characteristics of the final product. Due to the depletion of industrial reserves of natural raw materials, it is relevant to use waste from various industries, such as secondary kaolin and clay of the Angren deposit, waste from dust and gas cleaning (GCD) of "Uzmetkombinat" JSC and waste from the Toytepe fluorite enrichment factory (FEF).

RESULTS AND DISCUSSIONS

As can be seen from Figure 1, the diffraction maxima related to the minerals of β–cristobalite (β–SiO_2) with diffraction lines d=0.164nm are mainly fixed on the X–ray pattern of the waste samples of the FFE; α–tridymite with lines (α–SiO_2) d=0.381nm, α–

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 05 Issue 12 December 2022
DOI: 10.47191/ijcsrr/V5-i12-15, Impact Factor: 5.995
IJCSRR @ 2022
www.ijcsrr.org

quartz with line indices d=0,334; d=0,426; d=0,182nm, CaF_2 fluorite with interplanar distances d=0,315; d=0,1931; d=0.165nm; and also peaks with lesser intensity refer to augite minerals with lines d=0,6358, d=0,292nm; orthoclase $K_2Si_3AlO_8$ with lines d=0,324 d=0,216 d=0,668nm; and lines corresponding to the melt formed from the feldspar mineral KSi_3FeO_8 with lines d=0,380 nm (Figure 1) [5].

The obtained results of the differential thermal analysis of the flotation waste of the fluorite–concentrating production showed that on the thermogram curve (Figure 2) endothermic effects were found at temperatures of 98, 168, 200 ° C, associated with the removal of interlayer, hygroscopic and adsorption moisture.

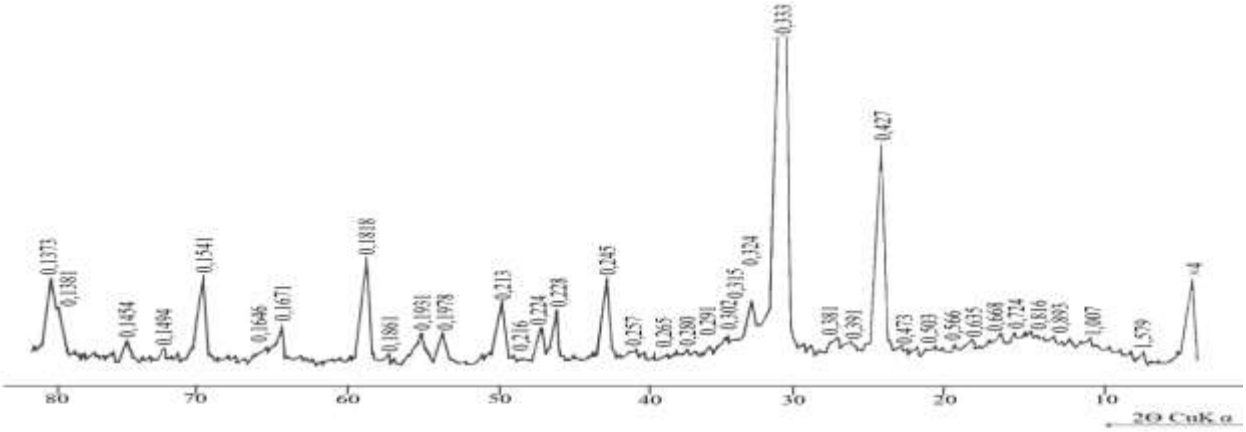

Figure 1. X–Ray pattern of Fluorite flotation enrichment

Exo–effects at temperatures of 392, 403,420°C are due to the burnout of organic impurities, endo–effects at a temperature of 495°C are shown by the removal of crystallization water. The exo–effect temperature at 610°C corresponds to the polymorphic transformation of quartz. The exothermic effect at a temperature of 846°C refers to the destruction of clay components and the beginning of the process of formation of a feldspar melt [6].

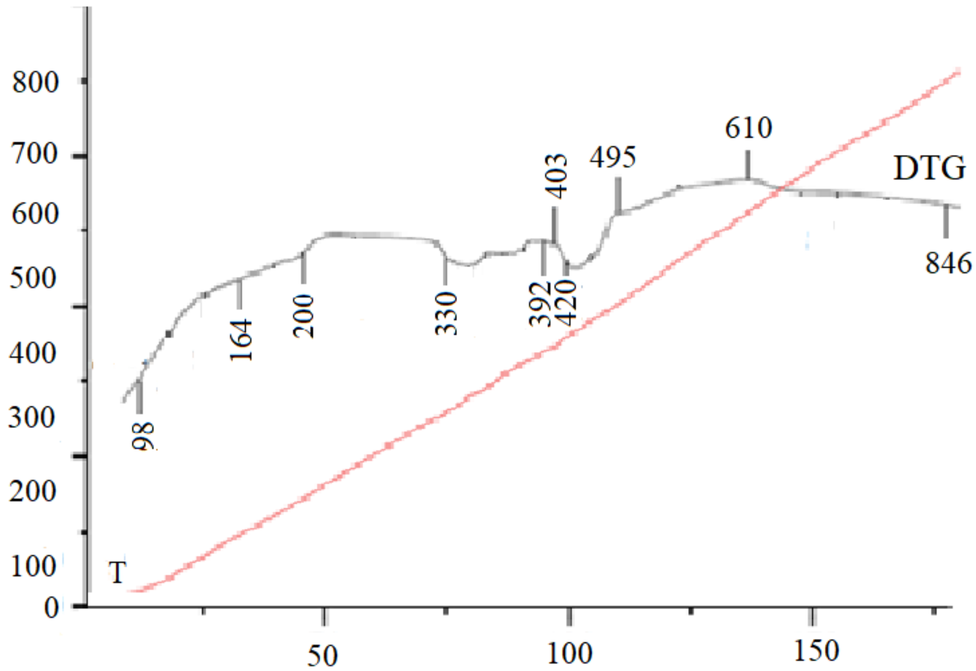

Figure 2. Differential–thermal curves of Fluorite flotation enrichment (FFE) enrichment production

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 05 Issue 12 December 2022
DOI: 10.47191/ijcsrr/V5-i12-15, Impact Factor: 5.995
IJCSRR @ 2022
www.ijcsrr.org

It should be noted that the clay components, including kaolins and clays of the Angren deposit, consist of a sillimanite group in the form of kaolinite, kyanite, sillimanite and andalusite, which have the same composition, corresponding to the formula Al_2O_3 SiO_2. structures leading to neoformation, and all minerals pass in the form of crystalline phases of the mineral mullite ($Al_2O_3{\cdot}2SiO_2{\cdot}2H_2O$), according to chemical reactions:

$2(Al_2O_3{\cdot}2SiO_2)+2CaF_2 \rightarrow 2CaO{\cdot}Al_2O_3{\cdot}2SiO_2+SiF_4+SiO_2$ (1)

$Al_2O_3{\cdot}2SiO_2{\cdot}MgO \rightarrow MgO{\cdot}Al_2O_3+SiO_2$ (2)

$4(Al_2O_3{\cdot}2SiO_2)+FeO \rightarrow FeO{\cdot}Al_2O_3+3Al_2O_3{\cdot}2SiO_2+6SiO_2$ (3)

During the heat treatment of a composition based on Angren kaolin, clay and gas cleaning dust, the amorphous structure of kaolin first decomposes, as a result of which it dehydrates with the formation of metakaolinite, sillimanite and free quartz, then metakaolinite with an increase in firing temperature passes into the mineral mullite. Further, mullite interacts with hematite minerals, which are contained in gas cleaning dust and ferruginous spinel, ferruginous clinoenstatite and free quartz are formed.

At the same time, sillimanite also interacts with wuestite minerals and initially forms ferruginous clinoenstatite as an intermediate phase of this reaction. Further, in the final result of the solid–phase chemical reaction between Angren kaolins or clays and gas cleaning dust, ferruginous spinel, mullite and a high-temperature form of residual quartz are formed [7–10].

According to the results of X–ray phase analysis of fired samples based on kaolin or clay and waste from the Toytepa Fluorite flotation enrichment (FFE) in the temperature range of 900–1250 ℃, it was also established that the above minerals were formed, with the corresponding diffraction maximum.

Table 1. Chemical compositions of raw materials used

Name of raw materials	Oxide content (mass, %)									LOI, mass,%
	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	
Angren kaolin	67,40	18,28	0,37	1,12	1,70	0,20	0,70	0,45	0,10	9,17
Angren clay	52,11	25,68	0,39	5,79	1,09	1,19	0,96	0,92	1,73	10,14
Fluorite flotation enrichment (FFE)	86,3	4,33	0,80	4,00	0,78	1,61	0,30	0,30	0,01	0,01
Gas cleaning dust (GCD) *	6,44	1,33	0,01	47,6	21,3	1,49	–	–	0,01	11,86
*– in addition to these, gas cleaning dust contains, mass.% MnO – 2,68; ZnO – 4,7										

CONCLUSION

The compositions of ceramic masses for facing slabs based on Angren secondary kaolin and clay were developed, using metallurgical waste – iron –containing dust from the gas cleaning of "Uzmetkombinat" JSC and sandy waste from the Toytepe fluorite enrichment plant. With the help of differential thermal and X–ray phase analysis, the chemical–mineralogical compositions, exothermic and endothermic effects of the used components of ceramic masses were determined during their heat treatment. Thus, the suitability of using these wastes for the development of the composition of ceramic masses has been established.

REFERENCES

1. Buruchenko A.E. Evaluation of the possibility of using secondary raw materials in the ceramic industry // Glass and ceramics. No.2., 2006. – p. 44–46.
2. Minenkova G.Ya., Dyatlova E.M., Mikhalskaya T.I. Ceramic tiles based on local raw materials and industrial waste. Resource–saving and environmentally friendly technologies: Proceedings of the scientific and technical conference. Grodno, 1995. –p. 220–225.
3. Dyatlova E.M., Biryuk V.A. Chemical technology of ceramics and refractories. Laboratory practice. Minsk, BSTU. 2006. - p. 284.
4. Tolkacheva A.S., Pavlova I.A. Technology of ceramics for materials of electronic industry. Part 1. Uch. settlement Yekaterinburg. Ural University Press. 2019. - c. 124.ASTM–X–Ray Powder Diffraction Data File American Society for Testing and Materials., Philadelphia, 1988.
5. Ax N.D. Differential-thermal and thermoweight analysis of minerals. M.: Nedra. 1964. - p. 214.

6. Sidikova T.D. Solid–phase reactions during firing of ceramic materials obtained using industrial waste // Universum: Chemistry and biology. No. 5 (59), Scientific magazine, 2019.
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, 9–10, 2018. – p. 269–272.
8. Tairov S.S., Kadyrova Z.R., Sabirov B.T. The use of gas cleaning dust of metallurgical industries in the composition of ceramic masses for tiles. Materials Rep. Scientific and technical conf. “Modern problems and prospects of chemistry and chemical–metallurgical production”. Navoi, 2018. – p. 172–174.
9. Kadyrova Z.R., Eminov A.M., Abdurahmanov A.K., Bayjanov I.R. Der industrielle Einsatz des Usbekischen Primarkaolins Angren. Keramische Zeitschrift. Volume 52, № 11, 2000. – p. 1098.

Cite this Article: Tairov S.S., Kadyrova Z.R. (2022). Use of Industrial Waste in the Development of Ceramic Mass Compositions. International Journal of Current Science Research and Review, 5(12), 4512-4515