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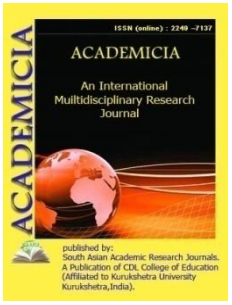

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IGNITED ROCKS - ENERGY-SAVING RAW MATERIALS FOR PRODUCTION OF PORTLANDCEMENT CLINKER

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ABSTRACT

The article discusses the possibility of using and the need to introduce local igneous rocks in order to reduce heat consumption in the production of Portland cement clinker. A list of large surface deposits of igneous rocks with explored and undiluted reserves of raw materials on the territory of Uzbekistan is presented. Their chemical and mineralogical composition and melting temperature range have been determined. The compositions of raw mixtures and the activity of clinkers when using igneous rocks as an aluminosilicate additive and flux as a mineralizer are indicated. The benefits and prospects of using igneous rocks in clinker production are summarized.

KEYWORDS: *Igneous Rocks, Aluminosilicate Raw Materials, Floating Mineralizers, Melting Temperature Range, Raw Mix, Clinker*

INTRODUCTION

The cement industry in terms of the consumption of fuel and energy resources is second only to the metallurgical industry, and a regular increase in prices for them year after year leads to an increase in the cost of products. It is known that one of the promising directions for reducing heat consumption in the production of clinker is the use of components with a high content of low-melting components, the presence of which in the composition of the raw mixture contributes to an increase in its reactivity, a decrease in the firing temperature and thereby - to reduce the cost of clinker and the final product as a whole.

The world practice of the production of Portland cement clinker indicates that to ensure the proper reactivity of the raw mixture, it is more preferable to use such raw materials as a conditionally clay component in which silica is presented either in an amorphous (X-ray amorphous) state, or bound in aluminosilicates and silicates [1-6]. These materials include numerous igneous rocks that make up the upper shell of the earth's crust. Igneous rocks occupy 95% of the volume of the Earth's outer shell, which is 25% of the continental area, are products of solidification of natural silicate melts - lavas and magmas and have a constant chemical composition, therefore they are of significant interest as a raw material for the silicate and, in particular, for the cement industry.In accordance with the chemical composition and properties, igneous rocks are divided into acidic ones with a content SiO_2over 65%, consisting of quartz, feldspars (such as granites) and basic, containing (40-52)% $SiO_2$and consisting mainly of plagioclases and pyroxenes (such as basalts). Due to the fact that magma erupted to the Earth's surface in the form of lava flows quickly solidifies, the formed rock usually has a fine-crystalline structure and contains a significant amount of a vitreous phase, which facilitates its melting. Therefore, igneous rocks are of great interest as a raw material for the production of Portland cement clinker. The high content of iron oxide in the chemical composition of igneous rocks makes it possible to use this iron-containing component as a mono-additive and as a flux-mineralizer of raw mixtures in compositions together with limestone and clay components.

To solve the urgent problem of reducing heat consumption for the production of clinker, it was necessary to search for analogues of the above components within the raw material base of Uzbekistan. According to the Committee of Geology of the Republic of Uzbekistan, on the territory of the republic there are large surface deposits of igneous rocks with explored and undiluted reserves of raw materials, such as: Hawasai basalts - on the southeastern slopes of the Kuramin ridge; Beshkizylsay - in the area of the village. Nevich, Chatkal ridge; Asmansay basalts - in the north of the Nurata ridge; diabase-pyroxenites of the "Karatash", "Belyaushsay-I" and "Belyaushsay-II" deposits, the Tillatag deposit of the Navoi region; Vakhshivardiabase-porphyrites - on the western spurs of the Gissar ridge; metabasalts of Uchkuduk, Northern Tamdytau; mrachibasaltsChazak and Gaga; diabase-porphyrites of the Pistalitau and Arvaten deposits in the Jizzakh region; diabase-porphyrites and andesite-porphyrites of the Kainar-Shavazsai deposits in the Tashkent region; diabase-pyroxenites of the Kizil-Olminsky deposit in the Surkhandarya region; diabase-porphyrites and basalts of the Markhamat deposit in the Andijan region, etc.

Studies of the chemical and mineralogical composition of rocks of the indicated deposits show that the content SiO_2they belong to the group of basic igneous rocks with a fine-crystalline structure, which ensures their low melting point $(1080\text{-}1200)^0$Cand the possibility of obtaining a mobile silicate melt when used in the composition of a clinker raw mixture as an aluminosilicate component. The presence in the composition of igneous rocks of Uzbekistan (from 4 to 14)% Fe_2O_3predetermines their purpose as iron-containing corrective additives to clinker raw mix.

Iskandarova M.I., Pulatov Z.P., Butaev E.M. et al., diabase-porphyrites of the Pistalitausky, Arvatensky and basalts of the Asmansai deposits of the Jizzakh region, diabase-pyroxenites of the Belyaushsai-I, Belyaushsai-P of the Tillyatag deposit in the Navoi region, diabase-porphyrites and andesite-porphyrites of the Kaynazar region -Olminsky deposit of Surkhandarya region, diabase-porphyrites of Markhamatsky deposit of Andijan region, etc. as alternative

sources of unconventional raw materials that can replace traditionally used iron-containing and aluminosilicate components as an unconventional mineralizer and conditional aluminosilicate component of Portland cement raw mixture [7-10].

Based on the results of experimental studies, the authors have issued practical recommendations on the advisability of partial or complete replacement of the clay component and the complete replacement of the iron-containing corrective additive with igneous rocks, which accelerate the processes of clinker formation due to the formation of silicate melt at the low-temperature stage and the formation of clinker at relatively low firing temperatures. (1300-1350^{0}C).

The limit of the chemical composition of the studied igneous volcanic rocks is determined,%: pp.=2,10-5,70; SiO_2=40,50-50,40; $A1_2O_3$ = 11,50-16,50; Fe_2O_3 = 6,60-13,90; CaO = 4,50-15,50; MgO = 2,80-8,2; Na_2O = 1,5-3,5; K_2O = 1,2-4,5.

Later, these studies were continued by OrazymbetovaG.Zh. replacement of the traditionally used ferruginous mineralizers in the composition of raw mixtures for burning clinker with basalts of the Berkuttau area of the Republic of Karakalpakstan [11-12].

It was found that the melting temperatures of igneous rocks are within (beginning-end 1100-1250)^{0}C. The acceleration of the process of mineral formation during the firing of raw mixtures containing igneous rocks is explained by the peculiarities of the chemical and mineralogical composition of unconventional raw materials. The reaction of mineral formation during the roasting of standard raw mixtures using an iron-containing component as a mineralizer (cinder, hematite rocks, AGMK slags, etc.) occurs up to a temperature 1300^{0}C. The reaction of interaction of free oxides with the formation of clinker silicate minerals mainly occurs in the solid phase. As the temperature rises to1450^{0}Cthe process takes place in the presence of a partial melt of aluminoferrite and aluminate phases. In raw mixes when using an unconventional mineralizer (igneous rocks), in which a glass phase is present, which melts at a relatively low temperature. At the same time, in contrast to standard raw mixtures, the reaction of mineral formation takes place in a silicate melt, which mainly contains SiO_2, $A1_2O_3$, Fe_2O_3andCaO. The introduction of igneous rocks into the composition of raw mixtures in an amount of (8-23)% contributes to the formation of a silicate melt of low viscosity and high fluidity already at a temperature (1150-1200)^{0}C, which leads to a sharp acceleration of the process of the reaction of mineral formation. Firing of raw mixtures containing igneous rocks proceeds intensively and clinker formation practically ends at a temperature (1350-1400)^{0}Cwith the formation of silicates, aluminates and calcium aluminoferrites, as evidenced by the insignificant contentCaO_{free} (less 1 % the masses) in cakes fired in a laboratory silite furnace with an exposure time of 10 min. At the same time, the crystallization of clinker minerals is characterized by uniformity and fineness.

In the proposed compositions of raw mixtures, the content of igneous rock (10-25)% is within the limits. When the content of igneous rock is more than 23%, the clay (aluminosilicate) component is completely absent. Under the conditions of firing a two-component raw mixture, with the complete exclusion of quartz-containing clay components, the reaction of formation of silicate, aluminate and aluminoferritic minerals occurs at a high rate at a relatively low temperature.

When using igneous rocks, it becomes possible to exclude from the composition of raw mixtures not only scarce and expensive iron-containing additives, but also clay shales, clays, loess-like

loams, the extraction of which is associated with the withdrawal from land use of fertile lands suitable for agriculture and the deterioration of the ecological situation in the regions. The use of a two-component raw mixture with the exclusion of clay components greatly simplifies the technological process of preparing the raw mixture, reduces the moisture content of the sludge in the wet method of production, in the dry method, due to the high flowability of the raw mixture, no clogging of the heat exchanger leaks occurs, a stable coating is formed on the surface of the refractory lining of furnaces, etc. .d. The use of igneous rocks as an aluminosilicate component and a mineralizer of the raw mixture helps to reduce the temperature of clinker formation, increase the productivity of furnaces and reduce heat consumption without deteriorating the quality of clinker and cement.

For the purpose of large-scale introduction of igneous rocks into clinker production, the Republican standard O'zDSt 2950-2015 “Raw materials for the production of Portland cement clinker. Technical conditions ", which regulates the chemical composition of igneous rocks suitable for use in clinker production: SiO_2 - not less 40%; Al_2O_3- not less 8%; MgO- not less 7%; SO_3- not less 2,5%; TiO_2- not less 2%; P_2O_5- not less 0,6%; $R_2O=Na_2O+0,658\ K_2O$- not less 6%.

Pilot tests carried out at JSC Kizilkumcement and JSC Kuvasaycement have convincingly proven the feasibility of using local unconventional raw materials - igneous rocks as a mineralizer and a conventional aluminosilicate component in the production of Portland cement clinker. With the development of the new technology, the hourly productivity of all rotary kilns at Kuvasaycement JSC increased to 20% (from 25.0 t / h to 30.0 t / h), the specific gas consumption per ton of clinker decreased by 11%, the activity of clinker increased from 43.0 MPa to 50.5 MPa, and at Kizilkumcement JSC the increase in the hourly productivity of the furnaces averaged 18.0% (from 114 t / h to 135 t / h), the decrease in the specific gas consumption per ton of clinker - (6 -8)%, an increase in clinker activity - from 40.5 MPa to 50.3 MPa.

The economic indicators achieved at the same time (availability and cheapness of unconventional raw materials, low firing temperature, an increase in the rate of mineral formation processes, a decrease in the cost of clinker, savings in fuel and energy resources consumption, etc.) dictate the need for a large-scale introduction of technology for the use of igneous rocks at all cement plants in the republic.

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