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Reactivity of Raw Materials for Optimization of Portland Cement Clinker Composition

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REACTIVITY OF RAW MATERIALS FOR OPTIMIZATION OF PORTLAND CEMENT CLINKER COMPOSITION

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Annotation: The northernmost territory of Uzbekistan is the Republic of Karakalpakstan, which occupies a vast territory, characterized by a variety of climatic conditions. To create the technological basis for the construction of new cement plants in the northern region, it is necessary to conduct complex technological tests of the cement raw materials of existing deposits with the issuance of optimal chemical and technological parameters for the formation of the composition of the raw mixes and their firing modes. For research work, limestone clays of the Dzhamansaysky deposit, basaltic rock of the Berkuttau section of the Kempirsaysky deposit and cinder of the Almalyk mining and metallurgical plant were used as starting materials.

The study of mineral formation processes and properties of firing products depending on the heat treatment temperature and the type of starting components. Development of recommendations for the manufacture of Portland cement clinkers and cements based on local materials.

The reactivity in various ratios of raw mixes and the optimization of compositions for laboratory tests were studied. Raw mixtures in various material compositions were studied for reactivity by firing in the temperature range (1000-1450)°C and subsequent analysis of the firing products for the residual content of free calcium oxide. The firing of tablet samples (d = h = 20) mm was carried out in a laboratory silica furnace with sampling in the temperature range (1000-1450)°C and 1450°C with a holding time of 30 min. According to the data set forth in table. 1., we can conclude that the processes of formation and assimilation of free calcium oxide in raw materials based on the tested raw materials proceed intensively.

The maximum amount of free calcium oxide is observed at a temperature of 1000 ° C. With increasing firing temperature, the content of free CaO sharply reduced due to the onset of mineral formation processes.

Firing products synthesized at a temperature of 1450°C with 30 min exposure do not contain free CaO, which indicates its complete assimilation during the formation of clinker phases.

Keywords: limestone, clay, basalt, raw mixes, firing, reactivity, clinker

Introduction: Cement production is one of the most energy-intensive industries in the construction industry. The main share of the consumption of fuel and energy resources falls on the firing of Portland cement clinker in rotary clinker kilns at a temperature of 1450-1500°C. Given the enormous scale of cement production, the widespread introduction of energy-saving technologies, which save significant amounts of fuel and other types of energy, is of particular importance.

To create the technological basis for the construction of new cement plants in the northern region, it is necessary to conduct complex technological tests of existing cement raw material deposits with the issuance of optimal chemical and technological parameters for the formation of the raw mix and its firing modes.

Methodology: Chemical analysis of raw materials, raw mixes and firing products was performed in accordance with the requirements of GOST 5382-91 "Cements and materials of cement production. Chemical analysis methods "[1].

The compositions of raw mixes and clinkers for the production of general construction and sulfate-resistant cements were calculated according to a special program using the formulas of S. D. Okorokov in accordance with the requirements of O'z DSt 2801: 2013 "Portland cement clinker. Technical conditions "[2].

To grind the raw mixes, a laboratory ball mill was used when loading "grinding media: grinding material = 3.5: 1".

The fineness of grinding of raw mixes was determined in accordance with the requirements of GOST 310.2-76 "Cements. Test methods "[3].

Raw mixtures were fired in a laboratory silica furnace.

The temperature during firing was controlled by a TPR thermocouple with a secondary device.

Assessment of the quality of raw materials for the production of clinkers was carried out in accordance with the requirements of O'z DSt 2950: 2015 "Raw materials for the production of Portland cement clinker. Technical conditions "[4].

The content of free CaO in calcined clinkers was determined by the ethyl glycerate method [5].

To carry out research work, limestone clays of the Dzhamansaysky deposit, basaltic rock of the Berkuttau section of the Kempirsaysky deposit and cinder of the Almalyk mining and metallurgical plant were used as starting materials.

Discussion results: After discussing the calculated data for testing to determine the reactivity of raw mixes based on compositions No. 6; 12; fifteen; 16 for clinker for general construction and sulfate-resistant cements.

Raw mixes No. 2; 3; 6; 12; 15; 16 were studied for reactivity by calcination in the temperature range (1000-1450)°C and the subsequent analysis of the calcination products for the residual content of free calcium oxide. The firing of tablet samples (d=h=20) mm was carried out in a laboratory silica furnace with sampling in the temperature range (1000-1450)°C and 1450°C with a holding time of 30 min.

The amount of free calcium oxide in the products of firing was determined by the alcohol-glycerate method according to GOST 5382.

The results of the determinations are given in table. 1.

Table 1. The content of free calcium oxide in the products of firing

№	Name and the material composition of raw mixes,%	The content of free calcium oxide,%, at temperature, °C						
		1000	1100	1200	1300	1400	1450	1450, 30 min exposure
1	***Raw mix number 2*** - Technological sample of limestone - 83.19 - Technological test of basalt - 16.81 *SC =0,90; n=2,72; p=2,31	30,10	21,15	15,45	5,00	0,95	0,02	-
2	***Raw mix number 3*** - Technological sample of limestone - 83.61 - Technological sample of basalt - 16.39 *SC =0,92; n=2,73; p=2,32	31,80	22,10	19,15	5,80	1,00	0,03	-
3	***Raw mix number 6*** - Technological sample of limestone - 83.52 - Technological test clay - 2.08 - Technological test of basalt - 14.40 *SC =0,90; n=2,80; p=2,47	32,85	22,05	15,70	5,95	1,12	0,08	-
4	***Raw mix number 12*** - Technological sample of limestone - 83.83 - Technological test clay component - 9.89 - cinders of Almalyk mining and metallurgical plant-	30,20	22,00	17,42	6,40	2,65	0,15	-

	6.28 *SC =0,90; n=2,17; p=0,95							
5	***Raw mix number 15*** - Technological sample of limestone - 84.10 - Technological test clay component - 9.32 - cinders of Almalyk mining and metallurgical plant- 6.58 *SC =0,92; n=2,12; p=0,90	33,40	24,10	20,20	7,35	2,90	0,20	-
6	***Raw mix No. 16 SSPTs*** - Technological sample of limestone - 82.72 - Technological test clay component - 8.90 - cinders of Almalyk mining and metallurgical plant- 8.38 *SC =0,87; n=1,94; p=0,75	27,94	21,10	17,35	6,05	1,78	0,15	-

a note: *SC-saturation coefficient

According to the data set forth in table. 1., we can conclude that the processes of formation and assimilation of free calcium oxide in raw materials based on the tested raw materials proceed intensively.

The maximum amount of free calcium oxide is observed at a temperature of 1000°C. With increasing firing temperature, the content of free CaO. sharply reduced due to the onset of mineral formation processes.

Firing products synthesized at a temperature of 1450°C with 30 min exposure do not contain free CaO, which indicates its complete assimilation during the formation of clinker phases.

The presence of basalt rock with a melting point in the range (1180-1190)°C in the composition of raw mixtures No. 2; No.3 and No.6 (Table 1.) intensifies the process of mineral formation and accelerates the assimilation of free calcium oxide, which is almost completed at a temperature of (1420-1450)°C, which is relatively lower than in raw mixtures containing cinder of the Almalyk mining and metallurgical plant.

Conclusions: Experimental data set forth in table.1., show that for firing raw mixes No. 2; No. 3 and No. 6, the optimal temperature range is (1400-

1420)°C. To complete the processes of mineral formation in raw mixes No. 12; No. 15 and No. 16, the temperature range rises to (1430-1450)°C.

Thus, it was experimentally established that raw mixtures based on the tested raw materials have a high reactivity. For further technological tests, a two-component raw mix of composition No.2 and a three-component raw mixture of composition No.16 (Table 1.) were selected for clinker for general construction and sulfate-resistant cements.

Reference:

1. GOST 5382-91 Cements and materials for cement production. Chemical analysis methods.
2. O'z DSt 2801: 2013 Clinker Portland cement. Technical conditions
3. GOST 310.1-310.4-81 Cement. Test methods.
4. O'z DSt 2950: 2015 Raw materials for the production of Portland cement clinker. Technical conditions
5. Butt Yu.M., Timashev VV Workshop on the chemical technology of binders. -M .: High school. -1973. -504 s