PHYSICO-CHEMICAL PROCESSES OF CEMENT HYDRATION USING SHALES

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Abstract. *The physical and chemical processes of hydration and the physical and mechanical properties of Portland cement clinkers were studied using Devanasay shale. It has been established that, in terms of the content of the main components, the obtained two- and three-component experimental Portland cements with different saturation coefficient and silicate module satisfy the requirements for industrial cements.*

Keywords: *Portland cement clinker, shale, limestone, slag, hydration, roasting, saturation coefficient, silicate modulus, free calcium oxide, chemical, component, X-ray phase, physical and chemical.*

The expansion of the raw material base of the construction industry, the development of building materials based on non-traditional materials instead of natural ones, today remains an urgent and relevant task for researchers working in this field. In this regard, the issue of involving in the production of clay shale from the Devanasay deposit of the Jizzakh region, which are not suitable for agriculture, as a potential and promising raw material component, is undoubtedly relevant in the production of Portland cement.

To conduct research, we used shale and limestone of the Jizzakh region of Uzbekistan, and also processed metallurgical slags of JSC «Uzmetkombinat» as an iron-containing component. The chemical and component composition of the prototypes of the raw mixture of Portland cement clinker are given in Table 1 and Table 2.3, respectively.

Table 1.

The chemical composition of the initial components of the raw mixture, reduced to 100 mass%

Compound	Oxide content, %								Sum
	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	SO_3	П п п	
Clayey	1,55	0,6	0,5	-	53,4	0,6	0,1	43,25	100
Limestone slate	68,70	16,7	2.18	2.66	2.9	2,82	0,11	3,93	100
Slag JSC "Uzmet-kombinat"	17,11	5,25	14.20	6.22	43,77	13,20	-	0,25	100

The calculation of Portland cement raw mix was carried out according to the generally accepted method [1-2], in particular with SF (saturation factor) - from 0.85 to 0.92; and n (silicate module) from 2.2 to 3.2.

To do this, we studied the melting temperature of prepared two and three-component Portland cement raw mixes with different silicate modulus and saturation coefficient. The results

of determining the beginning and end of melting of the samples showed (table. 2) that the melting temperature in two-component mixtures begins at 1290°C, and ends at 1400°C.

In three-component mixtures (table 3.), depending on the saturation coefficient and the silicate module, the beginning of melting occurs at 1300 ° C, and the end of melting occurs at 1390 ° C. Apparently, the role of slags and the content of low-melting compounds in shale play here.

Table 2

Saturation factor	Silicate module	Oxide content %				Temperature melting, in T° C	
		Clayey	Limestone slate	Slag metallurgical	Slag AGMP	start	end
0,84	-	77,88	22,12	0	0	1290	1380
0,85	-	78,07	21,93	0	0	1320	1400
0,91	-	79,25	20,75	0	0	1350	1400

Thus, to study the physico-chemical processes of hydration of the developed experimental compositions of Portland cement clinker, chemical-analytical analyzes were used.

Table 3

Saturation factor	Silicate module	Oxide content %				Temperature melting, in T° C	
		Clayey	Limestone slate	Slag metallurgical	Slag AGMP	start	end
0,85	2,5	76,67	18,83	4,5	0	1290	1380
0,88	2,5	77,3	18,33	4,37	0	1300	1390
0,88	2,7	78,92	18,89	2,19	0	1300	1380
0,89	2,7	79,10	18,73	2,17	0	1320	1390
0,90	2,5	79,37	18,83	0	1,8	1300	1400
0,88	2,5	79,92	18,32	0	1,76	1280	1380
0,85	2,5	77,43	18,67	0	3,9	1280	1380

The study of the physical and mechanical properties of the prototypes was carried out using standard test methods, using different saturation coefficient and silicate modulus. Tests of the physical and mechanical properties of prototypes of Portland cement from a three-component raw mixture, carried out in accordance with the requirements of SOSR, showed that with a saturation coefficient of SF=0.88-0.89 and a silicate module n=2.5-2.7, the prototypes show strength characteristics at 28-day hardening under normal conditions for bending within 6.2-6.6 MPa, and for compression within 41.0-42.2 MPa. At the same time, it should be noted that hydrothermal treatment at a temperature of 95 ± 5 ° C also leads to a set of strength within 50-60% of the grade strength (table 4.).

Physical and mechanical properties of experimental cements from a three-component raw mixture with different SF and n.

Table 4.

Name of samples	Content	Tensile strength, in MPa		
		Hydrothermal treatment at 95±5°S	Normal storage	
			3 days	28 days

	SF	n	bend	compression	bend	compression	bend	compression
Sample -4	0,88	2,5	4,7	31,8	4,8	30,4	6,5	42,2
Sample -5	0,88	2,7	4,5	31,5	4,6	29,3	6,2	41,0
Sample -6	0,89	2,5	4,6	31,0	4,7	29,8	6,5	41,8
Sample -7	0,89	2,7	4,5	31,9	4,9	30,0	6,6	42,0

The processes of hydration and hardening of cement stone is one of the main factors characterizing its performance properties. Numerous works of domestic and foreign researchers are devoted to the study of the processes of cement stone hydration [3-7].

In the process of hydration of cement stone, anhydrous clinker minerals calcium silicates, aluminates and aluminoferrites, interacting with mixing water, turn into hydrosilicates, hydroaluminates and calcium hydroferrites. The speed and degree of hydration processes depends on the fineness of cement grinding, the temperature of the hardening medium, the water-cement ratio, as well as on the mineralogical composition of clinker, the material composition of cement, etc. [3,4].

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