MISTI 67.15.35.

CHANGE IN STRENGTH CHARACTERISTICS AND PROPERTIES OF CEMENT WITH INTRODUCTION OF CHEMICAL INDUSTRY SLAGS

Estauova A.A.*, Suleimbek G.A.

M. Auezov South Kazakhstan University, Shymkent, Kazakhstan

***Corresponding author's e-mail:** Estauova_akmaral@mail.ru

ABSTRACT

This research work is aimed at introducing surfactants into the cement grinding process that contribute to improving the strength characteristics of cement and increasing the productivity of cement mills. In order to fully manifest the hidden astringent properties of granular electrothermophosphoric slags, they need special additives-activators (some alkalis, sulfates, Portland cement or a mixture of these substances). Depending on the type of additive, alkaline, sulfate and combined methods of slag excitation are distinguished. Modern knowledge and experience of construction, observation of cement hardening processes allow us to assert that it is impossible to create universal cement suitable for service in any conditions. In this paper, the issue of increasing the productivity of the mill, increasing the strength characteristics and utilization of chemical industry slags is solved.

Keywords: *clinker, gypsum, phosphoric slags, mineral additives, Portland cement, strength, surfactants.*

INTRODUCTION

The possibilities of using slags of electrothermal phosphorus production in the production of building materials are no less wide than metallurgical and fuel ones. The presence of impurities of phosphorus and fluorine compounds, higher silica content and less alumina determine some features of the use of this type of waste.

Most phosphoric slags are used in the cement industry. Phosphoric slag meets the requirements for active mineral additives of artificial origin. The relatively low content of $A1_2O_3$ causes less hydraulic activity of phosphoric slags compared to blast furnace slags. Under normal temperature conditions, electrothermophosphoric slag does not have astringent properties, and its strength under steaming conditions is also insignificant. However, phosphoric slags are well activated by alkaline pathogens, and therefore they are used in the production of slag-alkaline binders.

The possibility of complex activation of finely ground electrothermophosphoric slag with small lime additives (0.5— 3.0%), chloride, sulfuric acid and carbon dioxide salts of alkaline and alkaline-earth metals has been established. Brands of non-burnt salt-slag binders for processing: heat and humidity —M200—M500, autoclave-M300-M900. They are characterized by increased sulfate resistance; their use instead of cement is possible only in the manufacture of concrete and reinforced concrete products and structures without changing existing technologies with heat and moisture treatment in steaming chambers and autoclaves. The use of an annealed salt-slag binder allows you to combine the production technology of binder and cement-free concrete in one complex. At the same time, the production process of binders is simplified, which is reduced to drying and grinding of granular electrothermophosphoric slag together with the addition of lime-boiling water to a specific surface area of 2800-3500 cm^2. Since all types of salts used are water-soluble, their introduction into the concrete mixture is carried out with mixing water. One of the areas of application of an annealed salt-slag binder can be the production on its basis of lightweight concrete panels made of concrete of classes B3.5-B10 and structural expanded clay concrete products made of concrete of classes B15-B25 [1].

MATERIALS AND METHODS

Frost resistance of expanded clay concrete of classes B3,5-B10 is more than 35 cycles, classes B15—B25 — more than 50. The adhesion strength of expanded clay concrete with reinforcement on a salt-slag binder is 3.06-4.14 MPa, which corresponds to the adhesion of cement expanded clay concrete with reinforcement. The chemical composition of phosphoric slags allows them to partially or completely replace the clay component in the production of Portland cement clinker. With the addition of 3-5% slag, it is possible to thicken the raw sludge and reduce its fluidity as a result of coagulation. With an increase in the dosage to 8-10%, the sludge again acquires a satisfactory spreadability.

Phosphoric slags containing up to 2.5% P_2O_5, fluorine 1-2% and manganese oxides 1 - 1.5% are complex mineralizers and alloying additives that accelerate firing and positively affect the activity of Portland cement clinker. Phosphorus oxide promotes the growth of clinker activity at its content of no more than 0.3%, and at a higher level, the normal process of clinker formation is disrupted and the quality of cement decreases. To obtain 0.2-0.3% P_2O_5 in clinker, the amount of phosphoric slags in the raw mixture should be 8-10%. It is noted that with such an amount of slag, the decarbonization of the raw mixture begins at a lower temperature and proceeds more intensively, and the sintering temperature decreases by 100-150°C. This reduces the specific fuel consumption for firing and increases the productivity of furnaces by 3-6%. At the same time, the hydraulic activity of the clinker significantly increases (by 5-10 MPa at the age of 28 days). The alloying effect of phosphoric slags is explained by the change in the properties of clinker minerals during the formation of their solid solutions containing P_2O_5. A change in the fine structure of the clinker leads to a decrease in the microhardness of the minerals of the phosphorus-containing clinker, which, in turn, reduces the specific energy consumption for grinding cement [2].

Due to the increased silica content, phosphoric slags can replace silica additives used in the production of sulfate-resistant Portland cement in the raw material mixture.

The coefficient of sulfate resistance and strength indicators of cement during hardening in sulfate solutions increase by 10-15%.

When the content of phosphoric slags in raw mixtures exceeds 10%, the silicate modulus sharply increases and clinker firing becomes difficult, despite the mineralizing effect of fluoride compounds. An increase in the amount of phosphorus oxide in cement by more than 1.5% slows down the setting time. Cement with a high content of P_2O_5 is characterized by a lower heat of hydration at an early age than cement with the same mineralogy, but made on a conventional clinker. At a later age, this difference is smoothed out.

Phosphoric slags are also effective as an active mineral additive when grinding clinker. They are introduced into Portland cement and slag-Portland cement in the same amount as granulated blast furnace slag. At the same time, the content of SiO_2 in them should be at least 38%, (CAO + MgO) - at least 43 and P_2O_5 - no more than 2.5%.

Unlike blast furnace slags, phosphoric slags are mainly represented by a glassy phase of pseudovollastonite composition, which lengthens the formation of the structure of slag-Portland cement. The setting of phosphorus-slag cement slows down as the content of slag in it increases. The strength indicators of this type of slag-Portland cement in the early stages are lower than usual, especially with a high content of phosphoric slags. However, at the age of 3-5 months, the strength of phosphorus-slag cement becomes higher than cement based on blast furnace slag. Like other types of slag-Portland cement, phosphor-slag hardens intensively during heat and moisture treatment, especially at high temperatures [1].

RESULTS AND DISCUSSION

A characteristic feature of phosphorus-slag cements is high sulfate resistance, provided by a low content of alumina in the slag and a decrease in the alkalinity of the medium as a result of the binding of calcium hydroxide with slag glass.

The strength of Portland cement depends on the test procedure: the composition of the mixture, its plasticity, the shape and size of the samples, the method of their manufacture and storage, etc. The strength test conditions are defined by GOST 10178 – 85.

The compressive strength of cement samples at the age of 28 days is called cement activity. According to GOST 10178 -85, the digital value of the brand characterizes the minimum compressive strength of the halves of the sample beams with a size of 40x40x160 mm, prepared from a 1:3 solution by weight with normal sand with a water-cement ratio of 0.4 and tested after 28 days from the date of manufacture. At the same time, the bending strength for cement beam samples M 400; 500; 550 and 600 should be at least 5.5; 6.0; 6.2; 6.5 Mpa after 28 days, respectively. According to GOST 10178 85, 300, 400, 500 grades are produced; 400 and 500 grades must contain no more than 60% of slag; 300 grade no more than 80% [3].

According to GOST 10178 -85, cement should have such fineness of grinding that at least 85% of the sample weight passes through the sieve No. 008 or the residue on the sieve does not exceed 15%. Most factory cements have a residue on the sieve of %008, equal to 8-12%.

The water demand of Portland cement, i.e. the amount of water introduced into the mixture to impart the necessary mobility, is relatively small compared to other binders. To obtain a test of normal density, depending on the fineness of grinding, the mineralogical composition of cement, the amount and type of active mineral additives, 24-28% of water is required. Of the cement minerals, C3A is characterized by the greatest water demand and C2S is the least. Since excess water remaining in the pores of the cement stone reduces its strength, reducing the water demand of cement contributes to improving its quality.

The rate of setting. According to GOST 10178 85, the beginning of cement setting should occur no earlier than 45 minutes, and the end = no later than 10 hours from the beginning of sealing. Both too fast and slow setting is a significant disadvantage of cement. If the cement seizes quickly, then it turns into stone before it has time to use. The use of slow-setting cements slows down the pace of construction [2].

Uniformity of the change in the volume of cement stone during hardening. The cement must pass the test for uniformity of volume change. The presence of free calcium oxides and magnesium oxide in Portland cement can cause cracking. This phenomenon is called the unevenness of the volume change during hardening. The reason for it is an increase in the volume of CaO and MgO during their interaction with water and the occurrence of internal tensile stresses in cement stone. The results of the study are shown in Table 1 and in the grind graphs of different samples 1, 2, 3.

Table 1- Diagram of cement grinding using phosphorous slag

Diagram of cement grinding using slag										
Images of Cement	Sampling time from the start of grinding									the remainder on the sieve
	2 min	4 min	6 min	8 min	10 min	12 min	14 min	16 min	17 min	
Sample no. 1	89.0	78.8	65.4	48.8	33.2	30.08	26.5	14.1	10.3	0.08
Sample no. 2	92.2	80.2	62.1	45.8	29.5	25.4	18.9	13.5	9.0	0.08
Sample no. 3	96	83.4	69.5	50.6	42.2	33.2	20.5	12.5	9.2	0.08
Sample no. 4	89.2	68.9	55.4	48.8	37.2	29.8	16.5	11.3	8.1	0.08
Sample no. 5	93.8	72.1	68.2	58.7	47.7	39.8	25.9	17.3	12.2	0.08

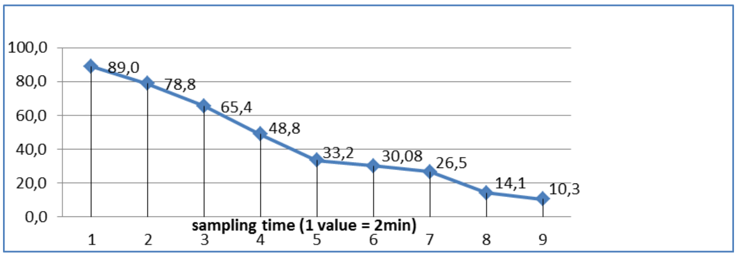

Fig. 1. Diagram of cement grinding using phosphorous slag (Sample no. 1)

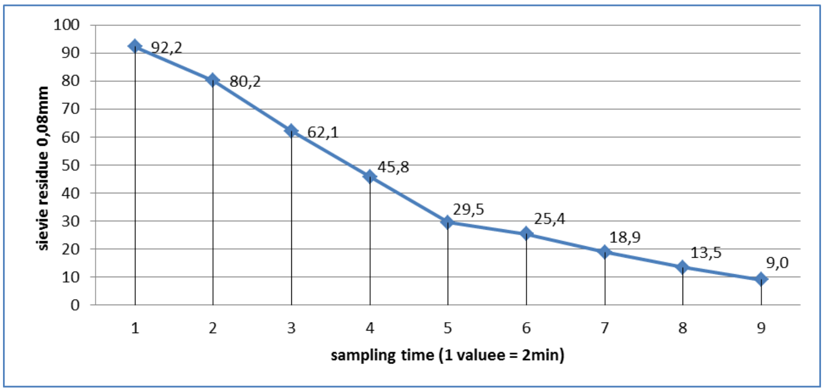

Fig. 2. Diagram of cement grinding using phosphorous slag (Sample no. 2)

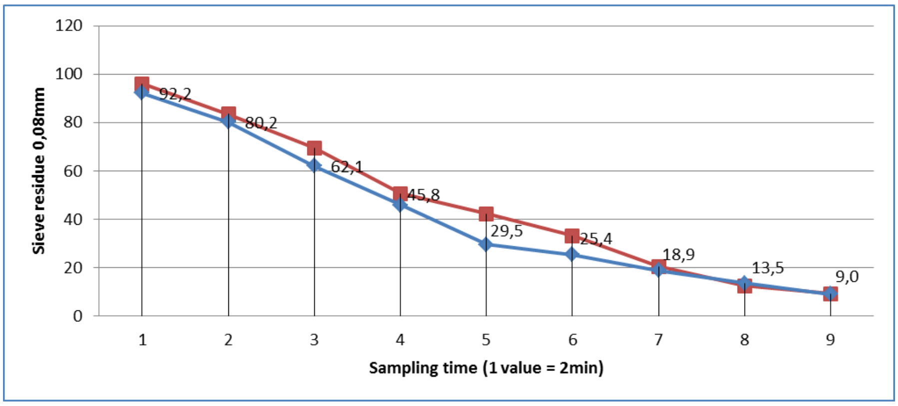

Fig. 3. Diagram of cement grinding using phosphorous slag (Sample no. 3)

CONCLUSION

Thus, fineness of grinding is estimated by two indicators: the amount of cement in % of the sample passing through a sieve with a certain size of holes (sieve analysis method), and the specific surface of the grains.

REFERENCES

1. Taimasov, B.T. *Tutastırğış zattardıñ xïmïyalıq texnologïyası: oqwlıq* [Chemical technology of binders] textbook, Shymkent: SKSU, 2018. - 382 p.
2. Taimasov BT, Alzhanova A.Zh. *Tutastırğış zattardıñ xïmïyalıq texnologïyası* [Chemical technology of binders] Textbook. - Almaty: Evero, 2015. - 380 p.
3. Taimasov B.T. *Tekhnologiya proizvodstva portlandtsementa* [Portland cement production technology]. – Shymkent, YKGU. 2004. –293 p.