The influence of additives of dehydrated clay on the properties of unburned binders and concrete on their basis

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Abstract: The purpose is development of technological bases of production of unburned alkaline binders and concrete on their basis from metallurgical and electro-thermo-phosphoric slags with an additive of the dehydrated clay with high operational properties. In this regard the increased indicators of physical mechanical properties of unburned alkaline binders and concrete on their basis were researched with addition of 25\% - dehydrated clay mixing alkalis. The influences of fineness grinding, a type of slag and an alkaline component, curing conditions on properties unburned alkaline binders and concrete on their basis, namely on changes of average density, water absorption, strength characteristics were researched. Thus, as a result of the conducted researches are received depending on a type of slag, an alkaline component, conditions of curing and fineness grinding of unburned alkaline binders and concrete on their basis with an additive of the ground dehydrated clay of grade from M300 to M1200.

1. Introduction
One of actual problems of production of cement in the Republic of Kazakhstan is lack of raw materials because the part of sources of the natural raw materials, being in available proximity, is exhausted and has no real replacement. In the foreseeable future, it will lead to inevitable partial or full replacement of natural raw materials technogenic which importance has to increase steadily including for nature protection reasons.

Now in Kazakhstan 10 million tons of electro-thermo-phosphoric slags and 85 million tons of metallurgical slags are accumulated, its yield makes from 700 thousand to 1 million tons per year [1-4].

Therefore research is directed on creation of industrial production of a new generation of hi-tech unburned alkaline binders of the Republic of Kazakhstan [5-7]. Its technology is based on a high grinding from metallurgical or electro-thermo-phosphoric slag with modifying additives and mixing solutions of alkaline components.

High physical and mechanical properties of concrete on the basis of unburned alkaline binders describing their durability and performance characteristics, are mainly connected with structural...
characteristics of material which are basically determined with composition of new formation in binder and by contact with filler, also increased density and largely self-contained pores [8-12].

2. Methods and materials
In this regard, increased indicators of physical and mechanical properties of unburned alkaline binders and concretes based on them were researched with the addition of 25% - dehydrated clay mixing alkalis. The experiments were carried out in the laboratory. Used electrothermophosphoric slag of Limited Liability Partnership «Kazphosphate» plant (New Jambul phosphorous factor) in Taraz town and metallurgical slags of Limited Liability Partnership «Ispat Karmet» in Temirtau town had following chemical composition:
- electrothermophosphoric slag, in weight, %: SiO2-42,0; CaO-45,1; MgO-2,4; Fe2O3-1,25; P2O5-2,60; Al2O3-2,65; SO3-0,43; K2O-0,15; F-2,20;
- metallurgical slag (blast-furnace slag), in weight, %: SiO2-34,82; CaO-39,16; MgO-6,18; Fe2O3-3,45; Al2O3-12,7; FeO-0,89; BaO-0,17; SO3-2,0; MnO-0,73; Na2O-0,72; TiO2-0,17.

Grinding of slag is carried in a mill Activator 4M. The samples of unburned alkaline binders was prepared in following composition: unburned alkaline binders: quartz to sand = 1:3.

For determination of degree of fineness of binder were used by PSH-12. Average density, water absorptions and strength characteristics were determined by the state of sectoral standard.

3. Results and discussions
The researching results of influence degree of fineness, type of slag and alkaline component, conditions of curing time on properties of unburned alkaline binders that changes in medium density, water absorption, strength characteristics of these factors are described with the dependences (Fig. 1,2).

The overall level of medium density of unburned alkaline binders on the base of electrothermophosphoric slag is lower on 0,8-1,2%, and water absorption is higher on 11,5-19% than on the basis of metallurgical slag independently on the kind of alkali component and hardening conditions, which is aligned with highly porous particles of dehydrated clay.

Depending on the type of alkaline component, hardening conditions and degree of fineness binder the average density of unburned alkaline binders on electrothermophosphoric slag ranges from 2,172 to 2,445 g/cm3, water absorption 3,2-3,5-5,0%, and on metallurgical slag ranges from 2,160-2,429 g/cm3 and water absorption - 2,9-4,5%.

After steam curing the density of unburned alkaline binders depending on the kind of slag, alkali component, degree of fineness of binder and presence of additives dehydrated powdered clay is higher on 0,3-0,5% than after uncured, water absorption is lower on 0,6-8%.

With increasing degree of fineness from 300 to 700 m2/kg of unburned alkaline binders the compression strength depending on the kind of slag, alkali component, amount of additive dehydrated clay and hardening conditions, increases on 2,1-3,5%, water absorption is reduced on 18,9-38,1%. Strength of UAB on the base of electrothermophosphoric slag depending on the kind of alkali component and hardening conditions is higher on compression - 3,5-21,5% and on flexing - 2,4-8,4%.

With increasing degree of fineness from 300 to 700 m2/kg of unburned alkaline binders the compression strength depending on the kind of slag alkali component and hardening conditions increases on 7-30,5%, and on flexing - 25-49,5%.

The researches of influence degree of fineness, kind of ash and alkaline components, hardening conditions at medium density, water absorption, strength of concretes based on unburned alkaline binders and also kinetics of curing time is similar to dependence given for unburned alkaline binders.

The analysis of obtained results of researches showed that the overall medium density of concretes based on CUAB unburned alkaline binders on the base of electrothermophosphoric slag is less on 0,15-0,9% and water absorption higher on - 8,1-17,2 % than on the basis of metallurgical slag independently on the kind of alkali component and hardening conditions.
Depending on the kind of slag, alkaline component, hardening conditions and degree of fineness of binder the medium density of concretes on the base of CUAB unburned alkaline binders on electrothermophosphoric slag ranges from 2,408 to 2,485 g/cm³ and water absorption - 2.6-4.3%, and on the basis of metallurgical slag in the ranges from 2.44 to 2.500 g/cm³ and water absorption - 2.1-3.6%.

After steam curing the medium density of concrete on base of unburned alkaline binders is higher than after natural curing on 0.2-0.6%, water absorption lower on 0.3-5.0%, depending on the kind of slag, alkali component, degree of fineness of binder and additives presence of dehydrated clay, with increasing degree of fineness from 300 to 700 m²/kg medium density of concretes on base of unburned alkaline binders, depending on the kind of slag alkali component, amount of addition of dehydrated clay and hardening conditions is increased on 0.3-1.2%, water absorption is reduced on 14.1-26%.

Depending on the kind of slag alkali component, hardening conditions and degree of fineness of binder strength of concretes of unburned alkaline binders ranges from 40 to 115 MPa - on electrothermophosphoric slag, and on metallurgical slag in the ranges from 32 to 105 MPa.

After heat and humidified treatment the strength on compression of CUAB is higher than after uncured up to 4.7%, depending on the kind of slag alkali component, tannin of grinding of binder and quantity of amount of additive dehydrated powdered clay.

With increasing of degree of fineness from 300 to 700 m²/kg strength of concretes on the base of unburned alkaline binders depending on kind of slag alkali component, amount of additive dehydrated powdered clay and hardening conditions, increases on 27-32%.

The results of physico-chemical studies have shown that the addition of dehydrated clay reduces maintenance the free highly soluble alkali.

The presence of the optimal content of additive dehydrated clay - 25% the content of free alkali is reduced on 18.3%. Perhaps this is a result of interaction between clay minerals and active ingredients, dehydrated clay alkaline compounds mix to form soluble products of hydration.

4. Summary
The influences of additives of the dehydrated clay on operational properties of unburned alkaline binders and concrete on their basis depending on a type of slag, an alkaline component, and conditions of curing and grinding fineness are researched. Thus, the results of studies depending on the type of slag alkali component, hardening conditions and fineness binder of unburned alkaline binders and concretes on their basis with the addition of powdered dehydrated clay marks from M300 to M1200 are produced.

The research was carried out in accordance with the following scientific and technical programs: “Scientific supplying of chemical industry development of the Republic of Kazakhstan” and “Presentation of innovation grants in the framework of direction Productivity – 2020”, UDK 666.974.6:666.972.16, state registration 0110RK00446, according to themes of the following agreements “Development of production technologies of the non-calcining binders and concretes on their base of natural hardening out of metallurgical industrial waste” and “Development of production technologies of concretes out of alkaline binders on the base of phosphorus and blast furnace slag”.

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Figure 1. Dependence of medium density, water absorption and strength of unburned binder on basis of electrothermophosphoric slag with addition 25% of dehydrated clay: a - liquid glass; b - caustic ash, composition: 1-st with $S_{\text{ss}} = 300$ m$^2$/kg; 2-nd with $S_{\text{ss}} = 500$ m$^2$/kg; 3-rd with $S_{\text{ss}} = 700$ m$^2$/kg.

--- after heat and humidified treatment;  --- after essential hardening;
**Figure 2.** Dependence of medium density, water absorption and strength of unburned binder on basis of metallurgic slag with addition 25% of dehydrated clay: a - liquid glass; b - caustic ash, composition: 1-st with $S_{ss}=300$ m$^2$/kg; 2-nd with $S_{ss}=500$ m$^2$/kg; 3-rd with $S_{ss}=700$ m$^2$/kg.

----- after heat and humidified treatment; after essential hardening.
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