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Techniques, Patterns and Mechanisms of Energy Conservation on the Base of Using of Plasticizing Agents in the Technology of Producing of the Cement Clinker

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Abstract: The results of the thermogravimetric analysis of the effect of different plasticizers on the physico-chemical processes occurring during the heating of the raw mix to 1000°C are represented. A comparative analysis of the endo- and exothermic peak of the reactions when plasticizers are heated (coal-alkaline reagent and calcium lignosulfonate technical), Latnensky clay deposits containing organic-burnable inclusion is adduced. The methods of reducing the moisture content of sludge, the introduction of gas detection equipment, information and analysis control systems and analysis of technological process are examined. The above analysis shows that the introduction of public energy-saving measures in the cement industry can significantly reduce the energy consumption for the production of cement. The research in the field of structural and rheological properties of the suspensions prepared on the basis of monomineral clay and carbonate raw materials, forming part of the raw cement slurry, made it possible to establish the selectivity of coal-alkaline reagent to the clay component of the cement slurry, depending on its mineral composition. It is also shown that the introduction of plasticizers makes it possible to reduce the energy consumption for clinker burning, not only by reducing the moisture content of sludge, but also due to the input of low-grade fuel contained in the reactants and the burnable plasticizing additives.

Key words: Rheological properties · Plasticizers feedstock · Mixture structure · Minerals · Clinker · Differential thermal analysis · Humidity · Energy saving.

INTRODUCTION

The process of the firing of a clinker in the production of cement is the most difficult and most energy intensive one, however, it is always possible to find energy sources in this process. In the technology of the firing of a clinker high-energy potential produced by burning fuel directly into the rotary kiln is used. The use of secondary energy resources, which include the thermal effects of exothermic reactions, is an important factor in reducing energy intensity and fuel-saving technologies in the production of clinker [1-7]. For example, in the Topkinsky cement plant fuel consumption for a long period was 185 kg/ton clinker and a high resistance lining 560 days is achieved. The main reason of such high performance energy saving lining resistance and heat exchangers was the stabilization of the feed slurry in the oven and heat engineering and stabilization process of the firing of a clinker. Low fuel consumption and increased furnace capacity is 78-80 tons/hour. It was the main reason for the high resistance of the lining and heat exchangers. High performance and durability and energy saving lining is observed in other plants, such as Belgorod's and Stary Oskol's plants and others.

In the technology of wet method of production of a clinker the problem of reducing the moisture content of sludge is relevant [1], because the average total natural clay and chalk humidity is about 20 % and the raw slurry in different plants fed into the furnace with a humidity of 37 to 44 %. In some cement plants (eg, Belgorod's and

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Stary Oskol's) reduction in moisture content to 36-37 % is achieved. However, in some plants sludge humidity supplied to the furnace remains high. In [1-2], the sludge moisture reduction by 1 % during the firing clinker kiln wet process makes it possible to reduce fuel consumption by 5 %.

Analysis shows that the introduction of public energy conservation in the cement industry allows to reduce energy consumption for the production of cement only on the step of producing clinker, at least on 7-10 %.

The purpose of the work is developing methods and ways of reducing power consumption when plasticizing agents in the feed mixture to produce cement clinker are administered.

To this End, the Work Was as Follows:

- Analysis of the mechanisms for reducing energy consumption in clinker burning through the introduction of low-grade fuels is contained in the reactants and the plasticizing additives burnable raw materials of cement production.
- Analysis of the patterns of moisture reduction cement raw sludge and development of the methodology used to reduce moisture allowing for the properties and mineralogical composition of the raw materials of various cement plants.
- Analysis of the structural and mineralogical patterns and mechanisms of pattern formation occurring in the mineralogical composition of the raw mix with the introduction of plasticizing agents.

These studies consist of three components, namely: the 1st one represents the direction of thermodynamic analysis of the processes occurring during the high heat plastifying agents, organic- containing burnable inclusion including Latnensky clay deposits; in the direction described two methods for reducing the moisture content of sludge by introducing plasticizing agents; the 3rd one shows the direction in study of the effect of plasticizing agents on the structural and mineralogical properties of the raw components that make up the basis of the mineralogical composition of the raw mix.

MATERIALS AND METHODS

To study the structural and rheological properties were selected model suspensions containing separately carbonate and clay minerals, the most typical materials used in the cement industry. Glinoobrazuyuschie minerals for research were isolated by elutriation : Montmorillonite - from the Greek bentonite, hydromica - of micaceous rocks of the Kursk Magnetic Anomaly (KMA) (Gubkin). Prosyanovskogo used kaolin deposit (Ukraine) and chalk deposits RANGE (Belgorod region). The chemical composition of the starting components is presented in Table 1. Clean the selected material was confirmed by X-ray [4, 6] and differential thermal analyzes [5].

To control the rheological properties of model suspensions used organic carbonaceous additive (USCHR). Coal-alkaline reagent sodium (TU 26.8-23690792-002:2006) - powder or granules, black; mass fraction of moisture, % - 14-30, the mass fraction of sodium hydroxide,% - 10-16; Gummatov mass fraction of sodium (based on the dry weight), % - 33-42, solubility, % not less than - 55. These types of plasticizing agents were subjected to differential thermal analysis.

The paper used the standard method of determining the flowability by blurring the standard cone tekuchestemera MChTI TN-2. The rheological properties of the test suspension was determined directly after the joint grinding of all components, including additives, to residue number 008 sieve 6-8 % spreadability and 45 mm. Due to the different structure of clay minerals (kaolinite, montmorillonite, illite) humidity suspensions have ranged based hydromica - 45,6 %, kaolin - 49,8 %, bentonite - 80,1 %, chalk - 36 %.

To identify the characteristics USCHR influence on the structure of model suspensions were prepared oriented units, that is large aggregates in which all particles are arranged so that they are approximately parallel to the basal plane. Aggregates were prepared by the unsolicited oriented test substance in water followed by precipitation of the particles on the flat glass surface.

For qualitative evaluation of the phase composition using X-ray diffraction patterns. Morphological characteristics of the particles, surface topography and structure of the surface layers were investigated by scanning electron microscope SU-1510. Thermal studies were carried out on the device simultaneous thermal analysis STA 449 F3 when heating source reagent to 1000 ºC (Fig. 1).

The Main Part:

Direction 1: Thermodynamic analysis of high-temperature processes occurring during heating and plasticizing agents Latnensky clay deposits containing organic-burnable inclusion.

Table 1: Chemical composition of raw materials (mass. %)

No cl.	Components	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	R_2O	SO_3	LWC
1	Chalk	4,44	1,17	0,68	61,21	0,29	0,16	0,08	41,88
2	Bentonite Greek	59,40	16,85	7,20	4,98	2,59	2,84	-	6,14
3	Prosyanovsky kaolin	49,40	34,93	0,59	0,56	0,46	1,23	0,43	12,40
4	Hydromica	66,20	20,05	2,05	1,01	0,64	2,60	0,10	7,35

LWC - losses when calcinating

Table 2: Thermal emission of reagents USCHR, LST and Latnensky clay

# cl.	Test sample	The total amount of heat, mJ	The heat per unit mass, mJ/mg	Change in mass, %	The total heat release per unit mass, mJ/mg
1	USCHR	63219	8569,5	67,90	10168
2	LST	49553	2014,0	88,39	12327
3	Clay Latnensky	15737	1108,0	24,12	1108

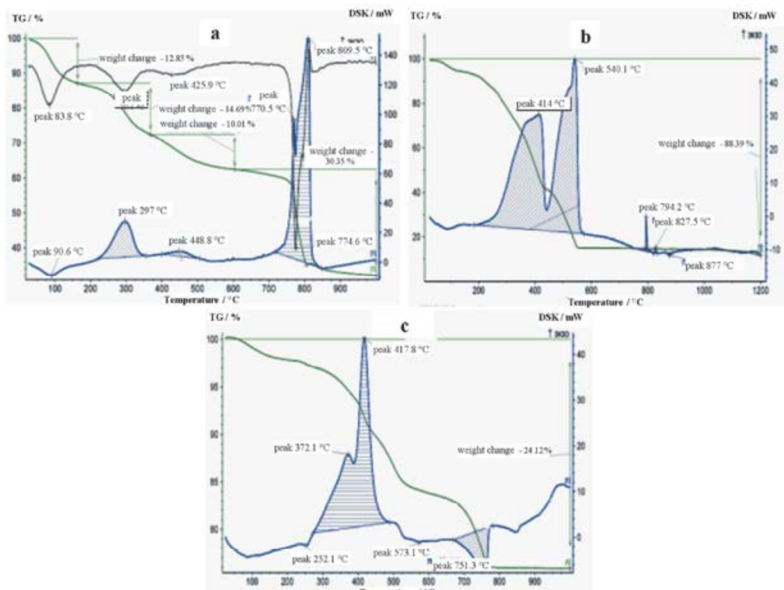

Fig. 1: Thermogram: a - coal-alkaline reagent (USCHR); b - calcium lignosulfonate technical (LST); c - Latnensky clay deposits

It is known that the presence of mixtures of raw burnable organic substances beneficial effect on the processes in the furnace and generally leads to appreciable reduction in fuel consumption. Specifically, for example, by administering Stary Oskol's in the cement plant raw mix Latnensky clay as a correction component for aluminate content, almost always leads to a considerable reduction in fuel consumption of 5 to 10 kg and stabilize the clinker burning process. It can be explained that the composition includes organic clay Latnensky inclusion in some cases up to 10-20 % during the heat treatment which further contribute to the high temperature heat kiln. It is widely used in cement manufacture plasticizers coal-alkaline reagent (USCHR) and calcium lignosulfonates technical (LST) also contain organic component, which is burning in the process of heating the raw mix in a zone of high temperatures can make some adjustments to the thermo-physical and thermodynamic processes sequential transformation of raw mix into clinker.

The main objective of this research was to assess the possibility of introducing a zone of high temperature processes clinker low potential energy of man-made origin. To solve this problem differential thermal analysis of plasticizing agents, namely coal-alkaline reagent (USCHR) (Fig. 1, a) was carried out and calcium lingosulfanate technical (LST) (Fig. 1, b) is the most used technology in the wet cement.

Picture 1 shows the thermogram coal-alkaline reagent (USCHR) lingosulfanate technical calcium (LST) and clay Latnensky. Fig. 1 shows that the main component of burnout heat USCHR occurs in the region 720-850 °C, that is, substantially coincides with the area of endothermic processes calcining cement raw batch, the temperature is the maximum temperature heat 809,5 °C and the total amount of heat due to high temperature heating was allocated to 63219 mJ sample weight of the sample was 7,3772 mg.

Zone heat LST (Fig. 1, b) is located within 300-600 °C, maximum heat dissipation 414 °C and 540 °C, that is the zone of heat LST located in the area of heating and endothermic reactions of dehydration of raw mix, as well as the collapse of the minerals contained in the feed mixture and the total amount of heat has been allocated 49553 mJ sample weight was 4,1245 mg.

Area of heat burnable Latnensky clay is in the temperature range 250-500 °C, that is in the heating zone feed mixture and the endothermic dehydration reactions montmorillonite, kaolinite and decomposition of minerals and other natural minerals contained in the feed mixture. The maximum amount of heat has been allocated 15737 mJ, the mass of the sample was 14,2 mg. (Fig. 1, c), with the maximum temperature of heat on the thermogram shows two values of 372 °C and 417,8 °C.

More detailed results of the analysis of the samples heat reagents USCHR, LST and Latnensky clay are presented in Table 2. Heat dissipation USCHR reagents, LST and Latnensky clay.

Analysis thermogram (Fig. 1, a and b) demonstrated that heat occurs in several temperature zones, so when heated USCHR additional heat is observed in the temperature range 220-350 °C and the temperature 400-500 °C and when heated LST two peaks slight heat at temperatures of 794 °C and 827 °C. In this regard, the data presented in Table 2 shows the allocation of the total heat input, mJ/mg. For the test samples USCHR and LST total heat release was respectively 10,168 mJ/mg and 12327 mJ/mg. Clay Latnensky represented one area of heat, in this context, the total heat of burn-out clay Latnensky was 1108 mJ/mg, but it should be noted that the mass loss of clay Latnensky was 24,12 mass. %, While the weight loss USCHR and LST was respectively 67,9 and 88,39 mass. %. Burn-out component Latnensky clay is 15-20 %.

CONCLUSION

Studies show that the plasticizing agents allocate a significant amount of heat as 1 kg. USCHR based on conventional fuel contains 0,376 kg of fuel and lignosulfonate comprises 0,456 kg of fuel, despite the fact that Clay Latnensky contains in its composition only 0,041 kg of fuel. However, for the adjustment of the aluminate component of the feed mixture requires the introduction of a few percent clay Latnensky thus burn-out component will be a few pounds of fuel.

Track 2: Methodology to reduce moisture sludge and assess the impact of plasticizing agents to increase mobility and viscosity slurry.

On Balakleysky cement plant natural properties of clays are such that to ensure the transport capacity of the sludge they require high humidity sludge to 46-48 %. In this regard, to reduce the slurry moisture content requires the use of plasticizers.

The main task of the data is presented in Table 3 to show the calculation method of sludge effect of humidity on the heat loss during the firing of clinker. In the heat loss from the exhaust gases are taken into account only the amount of exhaust gases due to changes in humidity and mud, respectively, changes in costs for clinker burning heat. Certain balance sheet items in the calculations in Table 3 are assumed constant (e.g. heat loss through the furnace body and heat loss to the grate cooler assigned to other losses).

These costs are much lower than the cost of heat for evaporation of moisture sludge and physical losses of heat from the exhaust (flue) gas. Since heat loss from the furnace body is about 5-6 % and heat loss to the grate cooler of about 2,5 %. For a more precise definition of these losses and the whole calculation process should be carried out and thermal engineering studies furnaces.

It should be noted also that the plasticizers of organic origin and these include the LST, in the process of firing burn and make extra amount of energy in a burn-out supplement. It also reduces the amount of heat. In this regard, to achieve specific fuel consumption 198 kg/ton clinker kiln 5×185 m may be possible and at higher moisture content than that shown in the calculation, for example, 39-39,5 % humidity. In order to determine this, more detailed thermal and thermodynamic studies roasting raw mixes and sludge, as well as the selection of more efficient plasticizers sludge [1].

The material presented in the Table 3 shows that the decrease in moisture content of sludge by 1 % can reduce the average fuel consumption for clinker burning of 5,3 % and 4,2 % were due to lower humidity and 1,1% by reducing the amount of flue gases.

Fig. 2 presents studies slurry Belgorod cement factory which show the influence of humidity and the introduction of slurry viscosity plasticizer. In this case, the critical viscosity of 0,1 Pas. Above this value, slippage rotor pump and the pump pumps the sludge. These data show that the slurry to reduce the humidity, e.g. up to 37 %, enough to introduce 0,5 mass. % LST. You need to either increase the concentration of the plasticizer, or use more effective plasticizer.

Table 3: Analysis of the influence of humidity on the fuel slurry in a furnace 5×185 m

No cl.	Humidity sludge, $W_{өё}$,%	Total fuel consum ption for clinker burning, $Q_ò$. kg conditional fuel	Fuel consumption by cost: The thermal effect of clinker, TEC: kg conditional fuel	Percentage of total costs, %	Fuel consumption for the evaporation of physical water slurry, $Q_{W sl.}$: kg conditional fuel	Percentage total costs, %	The heat loss with flue gases, $Q_{h.f.g.}$: kg conditional of fuel	Percentage of total costs,%	Heat loss through the furnace enclosure, $Q_{h.f.e.}$: kg conditional fuel	Percentage of total costs,%
1	46,8	246,1	59,8	24,3	119,6	48,6	49,1	19,9	11,4	4,6
2	45,8	240,0	59,8	24,9	114,9	47,9	47,7	19,9	11,4	4,7
3	44,8	234,1	59,8	25,5	110,4	47,2	46,3	19,8	11,4	4,9
4	43,8	228,4	59,8	26,2	106,0	46,4	45,0	19,7	11,4	5,0
5	42,8	222,9	59,8	26,8	101,8	45,7	43,7	19,6	11,4	5,1
6	41,8	217,6	59,8	27,5	97,7	44,9	42,5	19,5	11,4	5,2
7	40,8	212,5	59,8	28,1	93,7	44,1	41,4	19,5	11,4	5,3
8	39,8	207,5	59,8	28,8	89,9	43,3	40,2	19,4	11,4	5,5
9	38,8	202,7	59,8	29,5	86,2	42,5	39,1	19,3	11,4	5,6
10	37,8	198,1	59,8	30,2	82,7	41,7	38,0	19,2	11,4	5,7

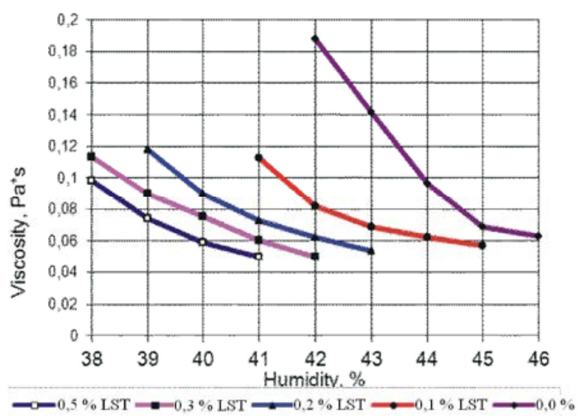

Fig. 2: The dependence of the viscosity of the sludge of different composition of "Belgorod cement" from moisture and LST

To this we must add that by reducing humidity and increasing the mobility of sludge, power savings when transferring 1 ton of sludge energy savings of 1,2 kWh. If we consider that in the preparation of one ton of clinker must be submitted to the furnace 2,5-2,7 tons of sludge, then, for example, to produce 3,5 million tons of clinker to be pumped around 9 million tons of sludge, therefore, additional energy savings to heat savings by reducing the moisture content will exceed 10 million KWh.

Conclusion: When burning clinker in cement kilns have certain reserves of energy saving, not associated with significant capital investment to modernize production. Moisture reduction of sludge by adding plasticizers can reduce fuel consumption by roasting and energy costs for pumping slurry, but requires a precise definition of the type and amount of plasticizer in the introduction of a specific plant and raw material.

Direction 3: Investigation of the influence of plasticizing agents on the structural and mineralogical properties of the raw components that makes up the basis of the mineralogical composition of the raw mix.

The rheological properties of cement raw sludge to a large extent determined by the clay component, which is composed of clay minerals (montmorillonite, hydromica, kaolinite). Due to the heterogeneous composition of the clay and carbonate raw materials used in the manufacture of cement USCHR appropriate to examine the impact on the structural and rheological properties of model based slurries monomineral raw materials.

For this Purpose, in this Section Were as Follows:

1. USCHR investigate the effect on the rheological properties of mono-mineral suspensions: one dominated by clay mineral - based on the Greek bentonite (montmorillonite), prosyanovskogo kaolin and carbonate component hydromica - chalk;
2. USCHR consider the impact on the structural changes in oriented aggregates derived from the above monomineral suspensions;
3. Determine the concentration of coal-alkaline reagent to obtain the desired spreadability of 54 ± 2 mm in model slurries.

To compare the results of research, model suspensions were prepared according to the data given in the Table 4.

USCHR effect of the addition on the rheological properties of suspensions studied is presented in Table 5.

Table 4: Initial flow and humidity prepared suspensions

No cl.	Suspensions prepared on the basis	The initial suspension of spreadability, mm	Humidity suspension of W, where the obtained initial flow properties, %
1	Chalks	45	36,0
2	Hydromica	45	45,6
3	Prosyanovsky kaolin	45	49,8
4	Greek bentonite	45	80,1

Table 5: The rheological properties of the suspension after administration USCHR

No cl.	Suspensions prepared based	The initial spreadability of suspension, mm	Spreadability of suspensions, mm after administration USCHR, mass. %			
			0,1	0,2	0,3	0,5
1	Chalk	45	116	124	124	125
2	Hydromica	45	56	72	88	92
3	Prosyanovsky kaolin	45	48	52	58	91
4	Greek bentonite	45	45	46	46,5	54,3

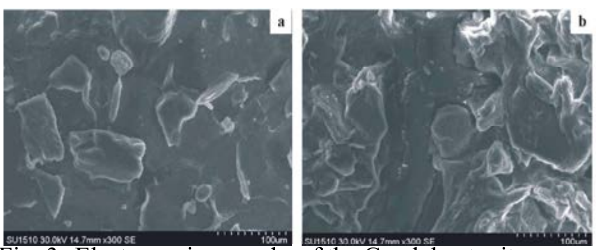

Fig. 3: Electron micrographs of the Greek bentonite: a - no additive, b - 0,5 mass. % USCHR

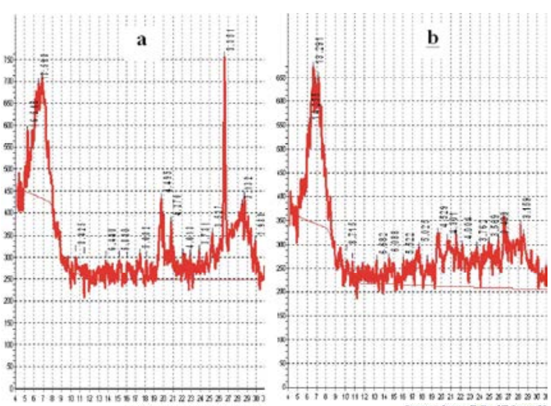

Fig. 4: X-ray diagram of Greek bentonite (angle of reflection 4 ... 30 °): a - no additive, b - 0,5 mass. % USCHR

The analysis of table data shows that USCHR selectivity occurs because when administered in a suspension prepared on the basis of chalk in an amount of 0,1 mass. %, The fluidity of this suspension is increased from 45 to 116 mm, that's 2,6 times.

Introduction to the slurry, prepared on the basis of kaolin Prosyanovsky USCHR 0,3 mass. % Leads to an increase in spreadability of the slurry from 45 to 58,8 mm, that's insignificant, only 30 % compared to suspension. Spreadability suspension prepared based on bentonite for introducing lignin-alkaline reagent 0,5 mass. %, was even smaller, that's 54,3 mm. However spreadability suspension prepared based hydromica when administered USCHR 0,1 mass. %, there is enough to set an increase of up to 54 mm. We analyze the impact of chemicals on the structural and mineralogical properties of the suspensions prepared on the basis of the Greek bentonite, hydromica, kaolin.

Greek Bentonite: In electron micrographs of bentonite (Fig. 3, a), montmorillonite structure has the form of large and small scales in the form of leaf-shaped light crystallized aggregates, without any elements of faceting. Introduction 0,5 mass. % USCHR (Fig. 3, b) changes the surface of the samples.

On radiographs of bentonite a distinct pattern with broad peaks reflections (d: 1,6673-1,2908 nm) (Fig. 4, a) is observed, which is a characteristic feature of the individual and montmorillionit. The presence of impurities reflect the diffraction patterns of quartz (d: 0,3351; 0,427; 0,1821 nm) [6].

In addition to the bentonite 0,5 mass. % USCHR observed decrease the content of the quartz (Fig. 3, b). Free silica solution satisfies in an alkaline medium (pH=8,45...8,5). Micelle formation takes place in his presence by the completion of the silicon surface of bentonite clay particles. Growth hydration shells around the grains of bentonite slurry is accompanied by increased spreadability from 45 to 54,3 mm (Table 5).

Hydromica: The study presented hydromica particles with an average size of 20-40 microns (Fig. 5). Hydromica is well diagnosed by X-ray analysis (d: 0,9936; 0,4969;

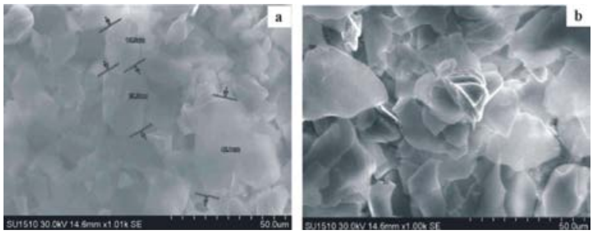

Fig. 5: Electron micrographs hydromica: a - no additive, b- 0,1 mass. % USCHR

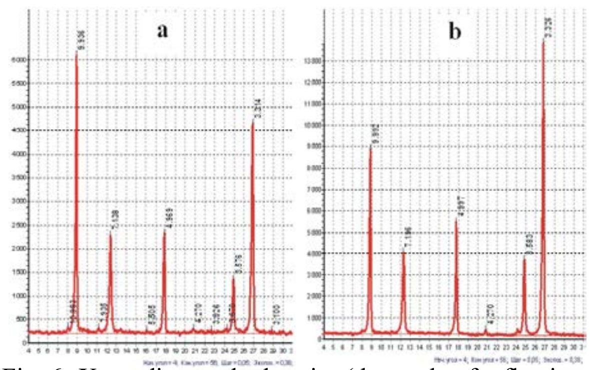

Fig. 6: X-ray diagram hydromica (the angle of reflection 4 ... 30 °): a - no additive, b - 0,1 mass. % USCHR

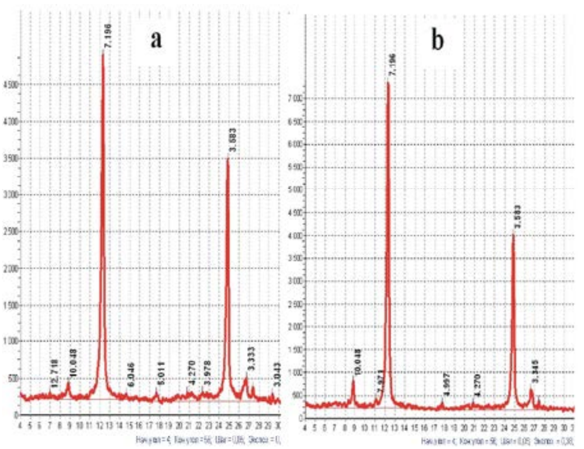

Fig. 7: X-ray diagram of kaolin (the angle of reflection 4 ... 30 °): a - no additive, b - 0,3 mass. % USCHR

0,3314; 0,1991 nm). The main rock-forming mineral is illite (d:0,3314; 0,9936; 0,1991 nm), secondary - kaolinite (d:0,7138; 0,3576; 0,2488 nm) (Fig 6) [6].

With the introduction of 0,1 mass. % USCHR increase intensity and interplanar distance reflexes illite. The suspension is dispersed flowability index value increases from 45 to 56 mm at the minimum input (0,1 mass. %) USCHR. Hydromicaceous suspension is in an alkaline medium ($pH_{Wednesday}$=8,96). With the introduction of a suspension of 0,1 mass. % USCHR rises sharply to 10,03 pH.

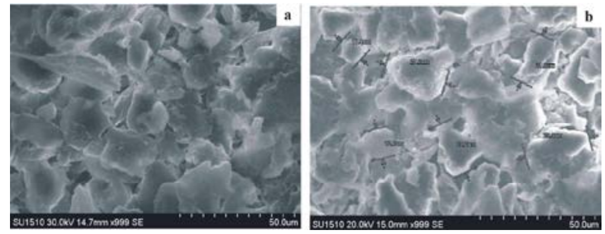

Fig. 8: Electron micrographs kaolin: a - no additive, b - 0,3 mass. % USCHR

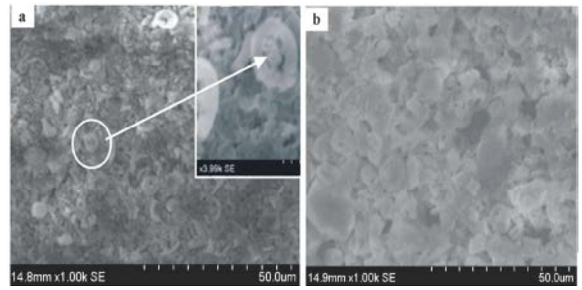

Fig. 9: Electron micrographs carbonate breed: a - no additive, b - 0,1 mass. % USCHR

Kaolinite: On diffractometric curves (Fig. 7) defined by the presence of kaolinite is very intense basal reflections (d: 0,7196; 0,3583; 0,2386; 0,1791 nm). There was a slight amount of hydromica (d: 1,0048; 0,5011; 0,3333 nm).

In electron micrographs visible wedge units of kaolinite flakes (Fig. 8).

Kaolin slurry has lower moisture content, as opposed to from montmorillonite, which means less. The number of surfaces is accessible to water. Introduction 0,3 mass. % USCHR increases the spreadability of suspension from 45 to 58,8 mm (Table 5) and raise the pH with 9,07 to 9,96. Reagent in waterspeeds up the process of dispersing.

Chalk: Asteraceae electron microscopy micrographs presented chalk particles (Fig. 9) that show that the chalk particles have a ring structure with aexpressed about the galley.

Cretaceous deposits of the Belgorod region are characterized by a low content of insoluble residue and a high content of carbonates. As a part of the Cretaceous there are organic residues that make up the majority of species (75 %). In the main part they are skeletal shells of planktonic algae coccolithophores and foraminifera (sometimes up to 40 %). The size of the skeletal remains 7-10 micron (Fig. 9). There coccoliths very different flat shapes and sizes.

Water-chalk slurry has a pH=9,14. If you enter 0,1 mass. % coal-alkaline reagent pH increases to 10,08, while significantly increasing the amount of active ions Ca^{2+}

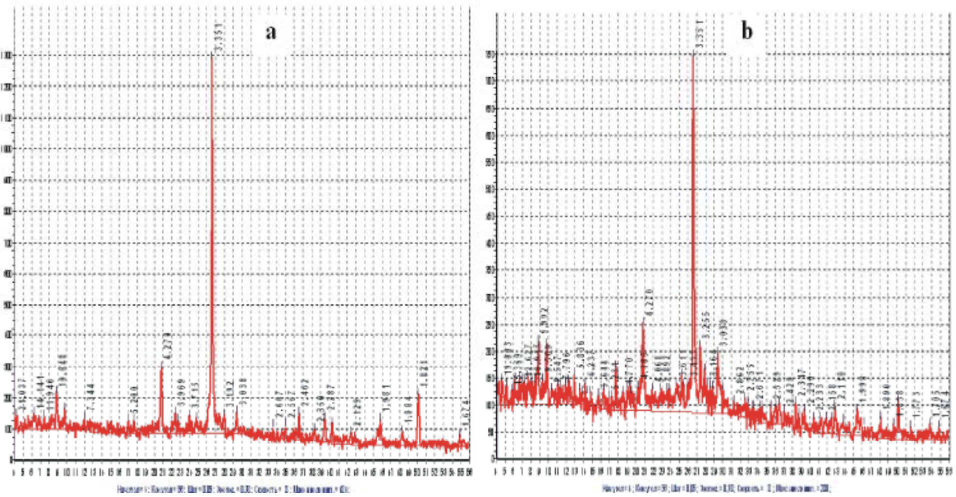

Fig. 10. X-ray diagram of chalk (the angle of reflection 4 ... 30 °): a - no additive, b - 0,1 mass. % USCHR

from 12,1 to 16,2 mg/l. Spreadability suspensions of the additive increases from 45 to 116 mm (Table 5). With the introduction of the reagent intensity of the main peaks of calcite and decreases the appearance of tumors observed (Fig. 10, b).

These scanning electron microscopy data showed that in the test model structures sludge structural changes mineralogical properties of the slurry suspensions. Thus, it is seen that depending on the mineralogical properties of the samples are observed opposing structure formation processes. In particular, for example, suspensions, prepared on the basis hydromica, the process of dispersing a particulate composition of the slurry, which increases and improves its mobility and suspensions prepared based Prosyanovsky kaolin coagulation process is the dispersion medium, which impairs mobility and causes reduce the spreadability of sludge suspensions.

CONCLUSIONS

On the limits of the rheological and microstructural properties of mono-mineral suspensions, we can predict the behavior of raw sludge multimineral the introduction of coal-alkaline reagent

1. Analysis of industrial furnaces shows that the clinker burning have certain reserves of energy saving, not associated with significant investments in the modernization of production. Reducing moisture content is sludged by adding plasticizers to reduce fuel consumption and power consumption to roasting for pumping slurry, but requires accurate determination of the type and flow additive in a particular plant species and materials.
2. Technologically and economically advantageously they are introduced into the feed mixture to the increased amount of 0,7-0,9 mass. % Plasticizing agents lead not only to reduce energy consumption in clinker burning, but are also to increase the productivity of processing equipment. As plasticizing agents emit considerable amount of heat, as 1 kg. USCHR based on reference fuel containing 0,376 kg of equivalent fuel, lignosulfonate containing 0,456 kg of fuel and this leads not only to reduce energy consumption in clinker burning, but also to increase the productivity of processing equipment. It is necessary to study the thermodynamic properties of the reactants and evaluation plasticizers and additional opportunities Single administration low potential energy in a preheating zone (450-500 °C) and calcining zone (~900 °C).
3. To select the most efficient type of thinner sludge suspensions and determine the optimal concentration of the introduction of plasticizing agents it is necessary to conduct comprehensive investigations including rheological analysis of the effect of plasticizer to reduce the moisture content of sludge, as well as the thermodynamic analysis, which determines the number of low-grade energy input in addition to the zone of high temperature processes of clinker.
4. Studies are needed for plasticizers to influence on structural and mineralogical properties of the starting mineral raw material used to produce the clinker, because it will determine the structural transformation of raw mix and evaluate the most effective impact of selected plasticizers.

5. As energy saving it is possible on the basis of evidence-based methods of analysis of production processes, equipment performance and efficiency of process control. Hence, the idea of energy conservation reserves can provide a complete and efficient energy audit of all processes, equipment and technical and economic feasibility of the proposed activities.

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