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EXPERIMENTAL STUDIES USING REAGENTS SOFTENERS FOR GETTING WATER COAL SUSPENSION FROM SHUBARKUL COAL'S SLIMES

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Modern development of power system is characterized by the reduction of share of an expensive liquid fuel use which is a valuable raw material for the refining industry and the increasing use of solid fuels. Stockpiles of high coal deposits are depleted due to the increase share of solid fuels. Furthermore, there is deterioration in the quality of solid fuels extracted by mining method. The transition to the development of powerful coal fields mined in the open way and its use as a fuel for power plants and other fuelusing devices are connected with certain difficulties. The main reason is high cost and power consumption of preparatory process in burning.

Keywords: Shubarkul coal's slimes, coal-water slurries, reagent-weight plasticizer, sodium humate, oil.

Many variants of flowchart of preparing highly water coal slurries (WCS) are now well-known and tested both in our country and abroad. The choice of rational flowchart preparation depends on many factors, that is, the properties and quality of the initial raw material, required quality of the suspension, types of additives used in the process, economic opportunities, etc. One can identify several specific technological operations used in preparation of coal-water slurry: 1 – grinding of coal to the 0-3 mm, 2 - coal preparation, 3 - grinding of coal to 0 - 200 microns by wet or dry way (wet dispersion is preferred), 4 - classification of the coal slurry and the suspension according to size, 5 - mixing the coal with water and reagents softeners.

The technological process of preparing WCS using a wet dispersion of coal has got the most widespread use both in our country and abroad.

The application of wet dispersing coal provides an effective combination of several technological operations (grinding, mixing and homogenization) in one or two devices, complete explosion and fire safety, manufacturability handling, etc. Despite the fact that the developed technological schemes differ in variety, there are two basic branches: application of a single- and two-stage methods of wet grinding.

The use of this or that technological scheme is due to the properties of used coal, requirements to the quality of ready WCS (mass fraction of solid phase, particle size distribution, rheology characteristics and stability), the efficiency of used reagents plasticizers, availability of technological equipment, etc.

Similar technological schemes are realized by other Japanese companies such as: "Kawasaki Heavy industry", "Kubota", "Japan company", "Mitsubishi Heavy industry", "Hitachi" and other Germany companies as well.

The essence of preparation process of water coal fuel is in grinding of coal particles mixing with water and reagent-softener at the same time.

Fractions of coal with a diameter of 1to10 mm were ground by electrohydraulic method in the laboratory of hydrodynamics and heat exchange of engineering thermophysics chair after Professor Zh.S.Akylbaev. The softener which was selected during scientific research work was added to the mass of ground coal and experiments on burning and ready suspension of water coal fuel were held in the laboratories. The installation for burning water coal fuel with the help of electric hydraulic impulse was collected. The diagram of burning water coal fuel in the laboratory is shown in Fig.1.

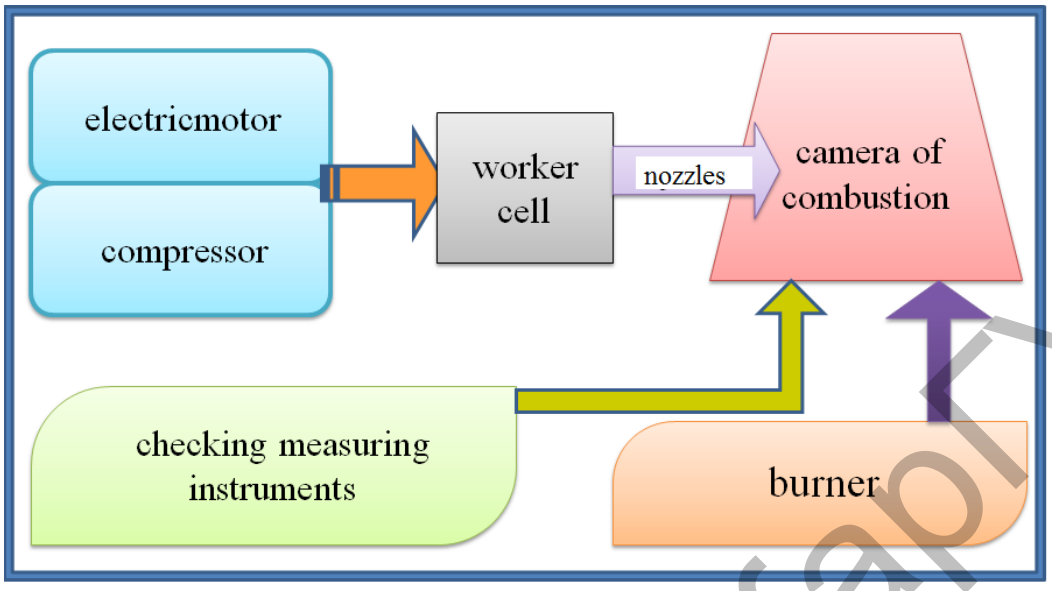


Fig.1. The schematic diagram of installation of water coal fuel burning in the laboratory conditions

As you can see, drawing consists of a compressor, nozzles, cells and burner. The principle of operation is as follows: water coal fuel gets into the cell. We close tightly a cell cover, heat the combustion chamber to a certain temperature by the burner and measure the temperature. The distillation of a liquid fuel comes from cell when it reaches maximum in the combustion chamber and when water coal fuel reaches 950-1000 degrees with the help of compressed air. Then we inject liquid fuel into the combustion chamber with the help of a nozzle. The burning of WCS happens at this very moment. The burning happens until 7 minutes.

Well- known reagents-softeners that are applied in different technologies of water coal suspensions preparation were selected on the basis of carried-out literary review.

We investigated the effect of such reagents as gelatin, fuel oil, lignosulfonate, sodium humate in this work. These reagents meet the above requirements and are cheap and readily available.

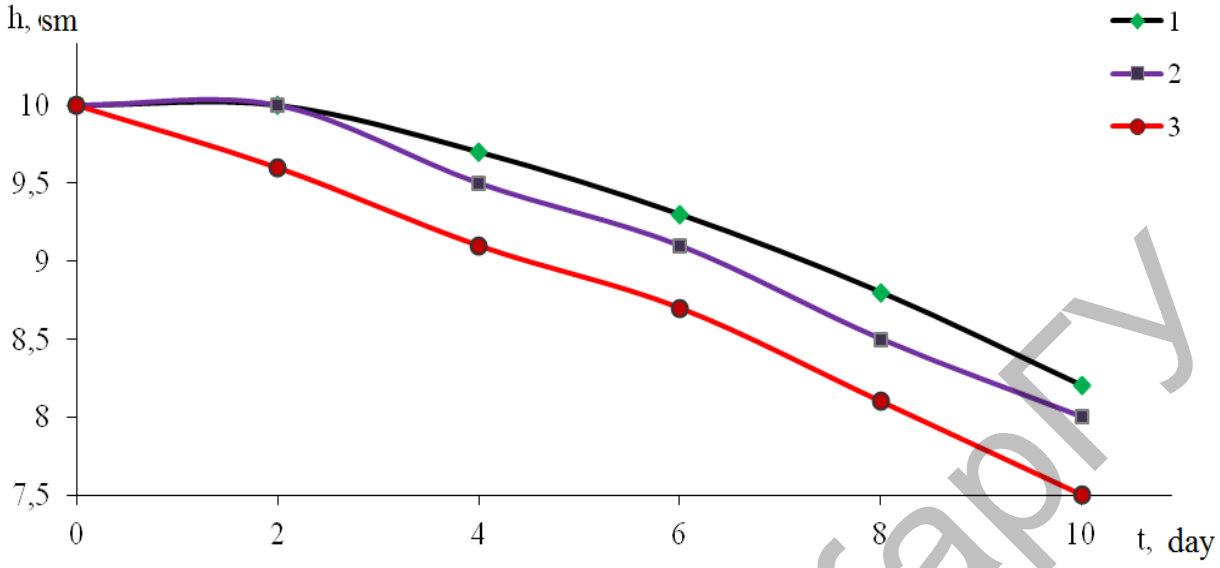
According to the research work, the efficiency of diluting and stabilizing effect of reagents – softeners on the high-concentrated water coal suspensions is connected with reagent adsorption on a surface of particles of a solid phase. The adsorption and the nature of adsorbent - adsorbate interaction depend primarily on the nature surface of the dispersed phase. The surface of carbon adsorbent section which is an aqueous solution in essence is a model hydrophobic surface while studying reagents' adsorption.

The stability of water coal slurries has been judged according to height of a layer of besieged dispersed phase and change of technical characteristics eventually.

Reducing the height of the solid layer testified the destabilization of the dispersed system that led to the gradual deposition and thickening of the coal particles.

As a result of the performed research on enrichment graphical subjection has been obtained that is presented in Fig.2-4. It should be noted that suspension in the presence of additives has good flowability. In the experiment, oil was added in various amounts ranging from 0.5 to 2% (Fig.2).

The graph shows that the addition of oil as a reagent-weight plasticizer in coal stability was observed in the homogeneity of the mixture for 2 days.



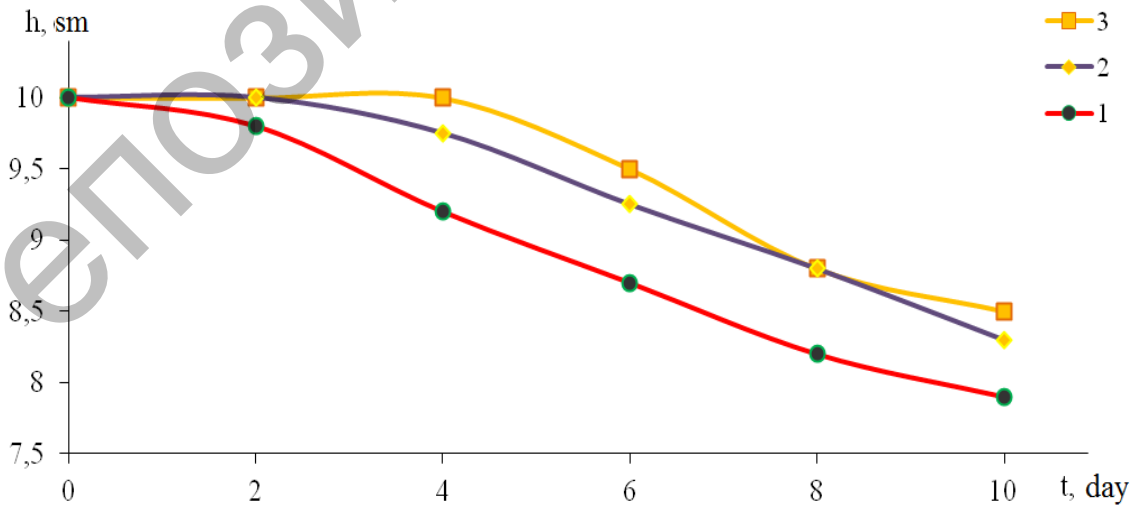
1 – 1 % by weight of coal; 2 – 0.5 % by weight of coal; 3 - 2.0% by weight of coal

Fig.2. Dependence of the layer height from the time of the dispersed phase (suspension with various amounts of oil additives)

Suspensions with the addition of gelatin (Fig.3) of 2% by weight of coal is stable for a long time, but with a decrease in gelatin content of less than 1.0% by weight of Shubarkul coal, there is a marked decrease in stability of the suspensions.

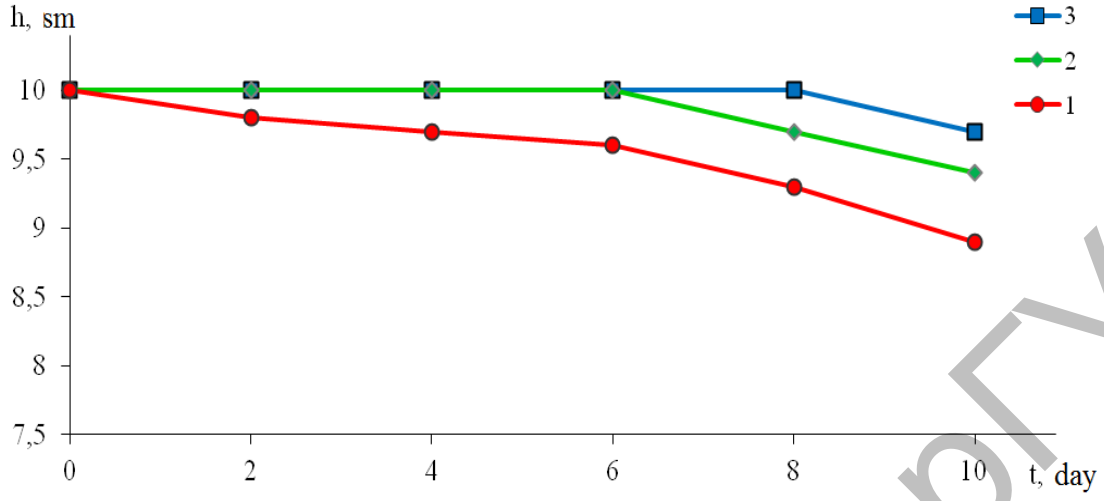
When you add a lot of gelatin in coal there is stability in the mixture homogeneity for four days.

Using humic preparation as a stabilizer (Fig.4) (sodium humate) yielded stable coal-water slurry, with stable, virtually no time-varying properties. Stability of coal-water slurries was maximum when using 1% sodium humate to the mass of coal.



1 - 0.5% by weight of coal; 2 - 1.0% by weight of coal; 3 - 2.0% by weight of coal

Fig.3. Dependence of the layer height from the time of the dispersed phase (suspension with varying amounts of gelatin additives).

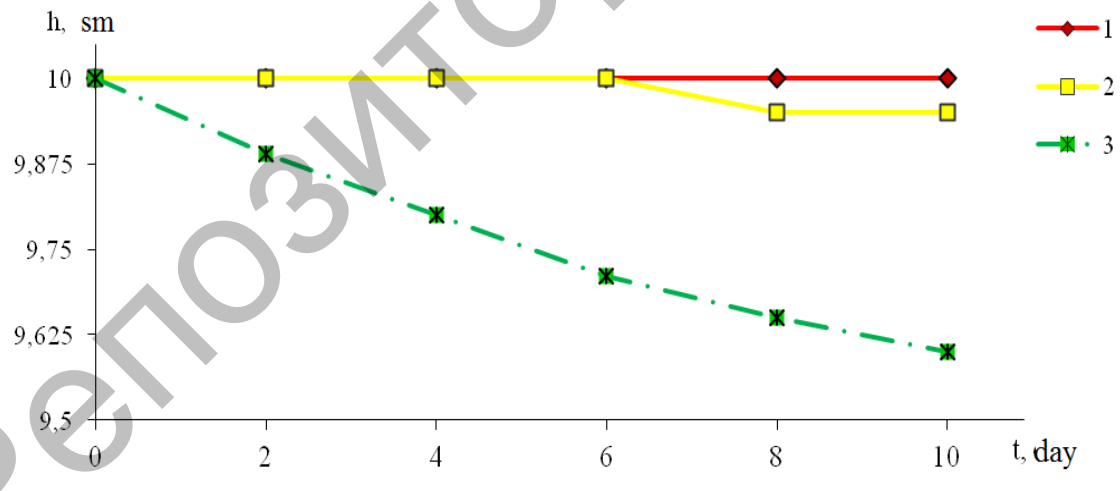


1 - 0.5% by weight coal; 2 - 2.0% by weight of coal; 3 - 1.0% by weight coal

Fig.4. The dependence of the dispersed phase layer height of the time (suspension with additives varying amounts of sodium humate)

The graph shows the stability of blend uniformity when using sodium humate continued until 8-9 days. Adding more than 2% of sodium humate material has no mpact on the stability (Fig.5).

From the obtained data it is clear that the best suspension with stability exhibit sodium humate additive. Due to the mentioned above requirements to coal-water slurry, intended to direct combustion in boilers it was very important to determine the viscosity of coal-water slurries obtained according to which any conclusions can be made about their strength.



1 - with the addition of sodium humate; 2 - gelatin; 3 – oil

Fig.5. Dependence of sediment dispersed phase height on time

Throughout the history of the coal use in the form of coal-water mixtures the possibility of their transportation over long distances has always been considered. A variety of substances have been used as the liquid phase, but water proved to be the most suitable. To date, the two most developed technologies of coal hydrotransportation are in laminar and turbulent regimes. By the first technology the coal-water slurry is prepared in a mass fraction of solids , typically up to 50 % consisting of a mixture of unstabilized large (up to a maximum size of 1.5 mm or more) and small particles of coal. The second technique is characterized by use of highly concentrated coal-water

slurry stabilized with a mass fraction of solids of 55% and a maximum particle size not exceeding usually 200 microns.

The further studies were carried out with suspensions prepared with the addition of sodium humate reagent plasticizer. The dependence of coal-water slurries viscosity (at a shear rate of 100 s-1) from the input amounts of sodium humate has been determined.

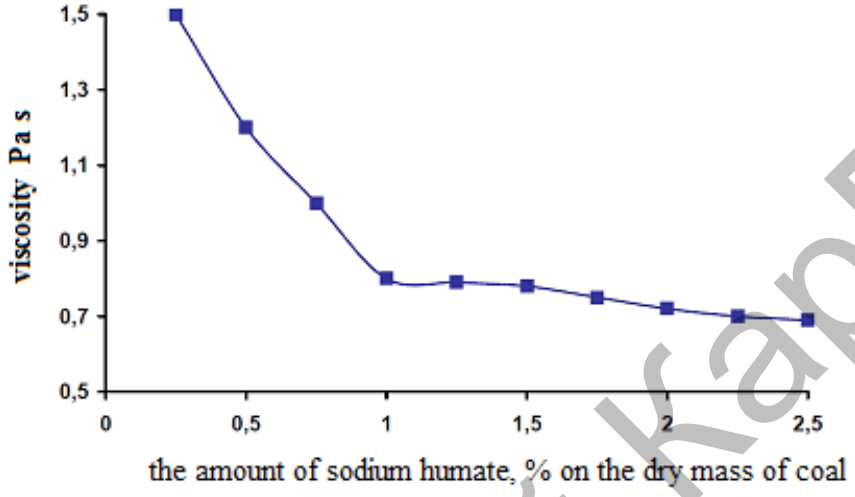


Fig.6. The dependence of coal-water slurries viscosity on the quantity of sodium humate additives

The data presented on Figure 6 shows that the desired viscosity is achieved upon applying of 1% by additives coal weight, adding more than 1% of sodium humate although it improves viscosity.

As a result of graphic dependences and the results of experiments analysis it has been found that the optimum binding of the reagent used in this study (fuel oil, sodium humate, gelatin) is sodium humate with a content of about 1%.

After very long-term storage (more than 30 days) coal-water slurry is gradually compressed to form loose sediments, highlighting the liquid phase contained in their structure. Presumably this is the result of coagulation of particles rearrangement , the contacts number of which obviously increases, which leads to compression of coal-water slurries and "squeezing" of which the dispersion medium . When applying mechanical action (stirring) there is a restoration of the original structure suspensions. Repeated experiments on the stability of these suspensions analyzing have shown that the suspensions of the gelatin additives and fuel oil stability has been declined. Whereas, its value remained unchanged in the coal-water slurry with the addition of sodium humate.

To some extent water-coal suspensions prepared with addition of sodium humate retain their formation existed at the inner structure. Thus, the mechanism of coal-water slurries structure data is different from the slurries prepared with other additives. This is probably due to the presence of denser adsorbed layers humates on smaller particles of coal, which accounts for their repulsion and prevents aggregation; like particles slide against each other and take the most advantageous position, characterized by minimal potential energy.

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