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THE REDUCTION OF THE CONSEQUENCES OF COAL PREPARATION FACILITIES EXPLOITATION BY OPTIMIZING THE POLYMERIC FLOCCULANTS EFFICIENCY RATE IN THE PROCESSES OF COAL SLUDGE DEWATERING

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In the last decade a significant growth in the flocculants usage at the coal processing facilities of Russia can be observed. The intensive usage of flocculants at the coal preparation plants have started back in the late 90s [1]. That process has been primarily observed at the coal preparation plants of Kuzbass. There, in the 1994, the technology of thickening and dewatering of flotation tails without the usage of sludge ponds was first set in motion at the CPP "Belovskaya".

At the beginning of 2000s many of the fabrics have chosen to adapt the technology that provided the usage of filter-presses as a mean to replace sludge ponds usage. At the same time, there have been started to be built coal preparation plants without the need to deploy various external sumps. Among other things, it became possible thanks to polymeric flocculants usage.

After that the demand on polymeric flocculants in Russia for enhancing dewatering processes at the coal preparation plants was constantly rising. Recently there has been a reduction in size of coal particles, that are headed to preparation plants. The changes in the technology of coal processing have lead to the situation, where flotation feed has suffered a significant increase of thin particles content, while some changes in coal mining technology have lead to an increase of fine clay particles in the feed of coal preparation plants. There is also an issue with the constant decrease in quality of mined raw coal. All of this requires the highest efficiency of flocculants that are used in dewatering processes [2].

One of the main trends in flocculant usage at coal preparation plants is the usage of flocculants to enhance thickening processes. Frequently there is an issue with coal tails storage. Building of new facilities, increase in plant capacities – all of that leads us to the necessity of designing and building of new tailing ponds. And those actions come at the cost of significant money and land expenses. To reduce those, many facilities are trying to store coal tails as compact as physically possible. To achieve that, the coal tails are undergoing the thickening in radial and paste thickeners. To significantly speed up those processes polymeric flocculants are used. A well-chosen floccu-

lant is capable to greatly influence the thickening process, but the consistency of that is directly dependent on the consistency of the raw coal in the plant feed.

Currently it is impossible to efficiently apply thickening as a measure to dewater coal sludges without the usage of flocculants, so it can be said that the efficiency of flocculant and the correct selection of a flocculant type to work within the specific conditions of each coal preparation plant are directly influencing the consequences of that facility operation for the regional ecosystem. Based on all this, it's clear that a reliable method to correctly choose a flocculant and evaluate its efficiency is needed. Often the process of choosing the right flocculant to work with is conducted right at the coal preparation plant. That applies some specific limitations to the methods that can be efficiently used in those conditions. But, as a whole, the thickening process can be fairly easily imitated with a simple lab equipment.

The main methods, that are used to analyze the efficiency of the thickening process with flocculants usage, are include:

Research setting method:

The initial coal suspension sample is poured in a glass, 0,5-liter cylinder. The initial sample should contain 25 grams of solid coal. A solution of dry polyacrylamide (volume 0,03 cm³, 0,15% concentration, is added in the cylinder with the initial coal sample. After that, the cylinder is turned over three times and is set aside for the solid particles to settle. During the settling of the coal pulp, the changes in the height of the uncolored layer and the height of the sediment, that is forming at the bottom of the cylinder, are monitored. With time, the height of the non-luminous layer decreases, and the height of the sediment slowly increases. The time when the lines of the non-clarified layer of pulp and sediment are combined will indirectly distinguish the flocculation capacity of the estimated material, since for different samples this time will differ. When studying the flocculation capacity of different coal sludges, the cylinder's volume, its height, the amount of the solid coal particles in the pulp, the pulp's temperature and the flocculant consumption remain constant. If this method is used to compare the efficiency of a variety of different flocculants, then a series of experiments with different flocculants must be conducted on the same coal sludges, at the same (and variable) volumes, with all the other experimental conditions left constant.

In the field of polymeric flocculants efficiency analysis exists a predetermined order to conduct laboratory tests. It consists of two stages: the preliminary test and the main test [3, 4].

The preliminary test:

The initial coal sample is placed in a cylinder with a 250 ml volume. In the second cylinder (which is empty), a flocculant solution (concentration 0,05%) with a 0,5 cm³ volume is placed. After that the coal pulp is shuffled between the cylinders 4 times. After this, the time is determined, for which the sedimentation front will pass between 230 and 190 ml marks on the cylinder. It is desirable that this time would be in the 10-20 seconds gap. If the time is above 20 seconds, the flocculant dosage should

be increased. If the time is below 10 seconds, the dosage should be decreased. After the initial dosage determination, one experiment with this dosage for each of the flocculants, which are present in testing, is carried. For each experiment, the time for the solid particles to pass between 230-190 ml marks is recorded, the size and stability of obtained aggregates and the clarity of water discharge in points (1 - not transparent, 5 - completely transparent) are visually measured. Based on the results obtained, as well as the information on which parameter (flocculant dosage, thickened product density, water discharge clarity) is a priority for the specific facility, 3-4 flocculants are selected from the whole set. For the main test, the flocculant that is currently used at the preparation plant must also be selected among the flocculants that were chosen during the preliminary test .

The main test:

The initial coal sample with the 500 ml volume is placed in a measuring cylinder. The cylinder is placed under a laboratory mixer with an anchor type impeller. The middle of the stirrer blades should be at the mark of 250 ml. The mixer's rotation speed should be 500 rpm. A flocculant solution is added in the process using a syringe after at least 20 seconds after the mixer's start have passed. At the same time, the stopwatch is turned on and exactly after 12 seconds (the average time that is sufficient to distribute the flocculant within the pulp) after the adding of the flocculant, the mixer is stopped. After that the time should be measured, at which the deposition front can pass between 450 and 350 ml marks on the cylinder. After the measurement is complete, the cylinder is left for 30 minutes. Then the volume of the thickened product and the water discharge clarity are measured. If during the test it was observed that the flocculant is not fully distributed among the pulp, the mixing time should be increased, and if the flocculant destruction has been observed, the time should be reduced. When carrying out the testing, it is necessary to perform one test without adding the flocculant and 30 minutes pause. In this case, if a clear precipitation front is formed, the time of its passage between the 450 and 350 ml marks is measured, and after 30 minutes - the volume of the condensed product and the water discharge clarity. Tests are carried out with various flocculant dosages. The minimum number of tested dosages is 4. At the same time, at least 2 identical tests must be performed for each dosage. Tested dosages must cover the operating range of flocculant dosage, that is already used at the specific preparation plant at the time of testing.

If the flocculant were not used on the plant before, a dosage is chosen for testing independently, the smallest of which provides the time for the precipitation front to pass between 450-350 ml in 30 seconds, and the largest - in 10 seconds. Tests must not be performed in a single row, there must be a change in the flocculant and the dosage every time a new test is conducted. This helps to eliminate the influence of the "aging" effect of the pulp and minimize the human factor. To convert the volume of the flocculant solution into a specific consumption (g/t), the

formula 1.1 may be used (present formula will only be valid when 500 ml cylinders are used in the tests, and the concentration of flocculant solutions is 0,05%):

$$D = 100 \times VSG \times DS \quad (1.1)$$

where D – specific flocculant consumption, g/t; VSG – coal pulp density, г/см³; DS – the amount of solid particles in the pulp, %.

By analyzing the methods described above, it can be concluded that the methodology for studying the flocculant efficiency in the thickening processes should include 2 stages of testing: preliminary testing and main testing.

Preliminary testing must be conducted in the volumes of 250 ml, to choose from a wide range of available flocculants just a small number of the most effective ones. The efficiency criteria will be the rate of precipitation, the amount of solid particles in the water discharge and the durability of the obtained aggregates.

Main testing must be held in a 500 ml cylinders, with a small row of previously chosen flocculants. The parameters, which must be obtained, will be the rate of precipitation, sediment density and the amount of solid particles in the water discharge.

Thereby it can be concluded, that, by paying close attention to the process of the flocculant selection, ensuring professionalism of the ones performing this process and timely reacting to the changes in the coal feed of the preparation plant, developing new and optimazing already existing methods for selecting and analyzing the flocculant efficiency, we can reduce the anthropogenic impact that the coal processing facilities inevitably will have on the ecosystem of their region.

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