UDC 53.097

THE INFLUENCE OF UNDERWATER SPARK DISCHARGE ON THE STRUCTURE OF SHUBARKUL COAL

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Nowadays petroleum is the main source of organic raw materials. Its limited world reserves and permanent increase in the cost of production due to involvement in exploitation more hard-to-reach fields stimulates the development of new technologies for chemical processing of alternative organic raw materials. Coal, world reserves of which are substantially larger than those of oil and gas, is considered in the future as one of the basic raw materials for the production of motor fuels and organic synthesis products. In this paper we propose to process Shubarkul coal using electric hydro-pulse technology. Application of electric hydraulic technique brings substantial economic benefits and contributes to significantly reduce harmful emissions into the environment or recycle harmful waste products. Study of influence of electric hydraulic effects on heterogeneous media due to rising costs for energy and mineral resources, the deterioration of the environmental situation is currently necessary and urgent.

Keywords: electric hydro-pulse plant, electric-hydraulic effect, shubarkul coal, coal-water fuel, electric discharge.

Kazakhstan has huge deposits of brown and hard coal of various metamorphism stages, which are widely used mainly for production of coke used in the steel industry, and for energy purposes. But these reserves of coal are not effectively used at present. So for the scientists, the age of technological progress poses the problem of development of optimal processing technology and use of coal. One of the efficient techniques of coal utilization is the process of obtaining motor and boiler liquid fuels, energy and process gases, semi-synthetic resins, soil conditioners etc., from coal [1]

Coal-water fuel (CWF) is a mixture (slurry) of finely ground coal and water. In some cases, the suspension may include various additives (surfactants, stabilizers, etc.) that change the stability, viscosity and other properties of the CWF. CWF can be used as a substitute for fuel oil, gas and coal. The main advantages of CWF are reduction in fuel costs compared to those of fuel oil and gas, as well as lower harmful emissions, particularly NO_x and the technological ease-of-use of coal in a liquid form. We propose a coal processing technology by using the electric hydro-pulse technique. It is possible to grind coal to a certain fraction by means of an electric discharge in a fluid. [2.3]

The essence of this method is that inside a volume of liquid held in an open or closed vessel, a specially formed electric pulse discharge of a certain form (spark, brush, etc.) is implemented. Around the field of its formation there is super-high hydraulic pressure capable to perform useful mechanical work and accompanied by a set of physical and chemical phenomena [4].

In the Laboratory of physics of pulse phenomena in heterogeneous media of the Chair of engineering thermal physics named after Prof. Zh.S. Akylbaev at E.A. Buketov Karaganda State University an electro-hydraulic plant for coal processing was installed.

The electric hydro-pulse plant is designed in the form of structural aggregates consisting of a pulse voltage generator, a triggered spark gap, a cell, an ignition block, a voltage divider, a current shunt and a control panel.

The scheme of the electric hydro-pulse plant and its separate units are shown in Figure 1.

The experimental stand works as follows. After switching on the control panel a control voltage is applied and the generator produces high-voltage pulses of specified energy which are transferred to the electrode system of the working cell area with the object of study through the triggered spark gap and high-voltage power lines. [5]

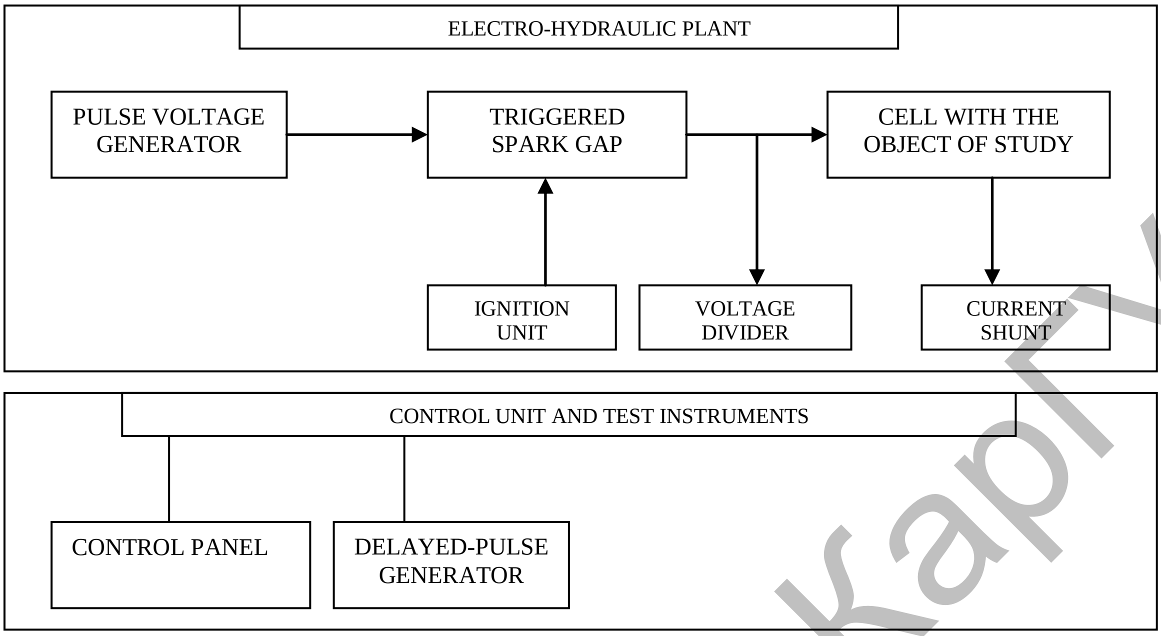


Fig.1. Block diagram of the electric hydro-pulse plant.

The working cell of the electro-hydraulic plant for coal processing was also installed in the Laboratory of physics of pulse phenomena in heterogeneous media.

There are two measuring electrodes inside the cell, one of them is fixed and the other is attached to the micrometer screw to adjust the distance between the electrodes. Figure 2 shows a general view of the cell designed for grinding coal. [6]

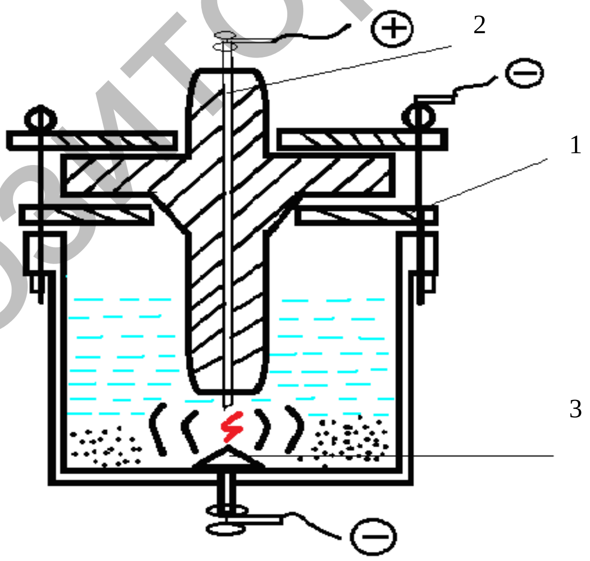
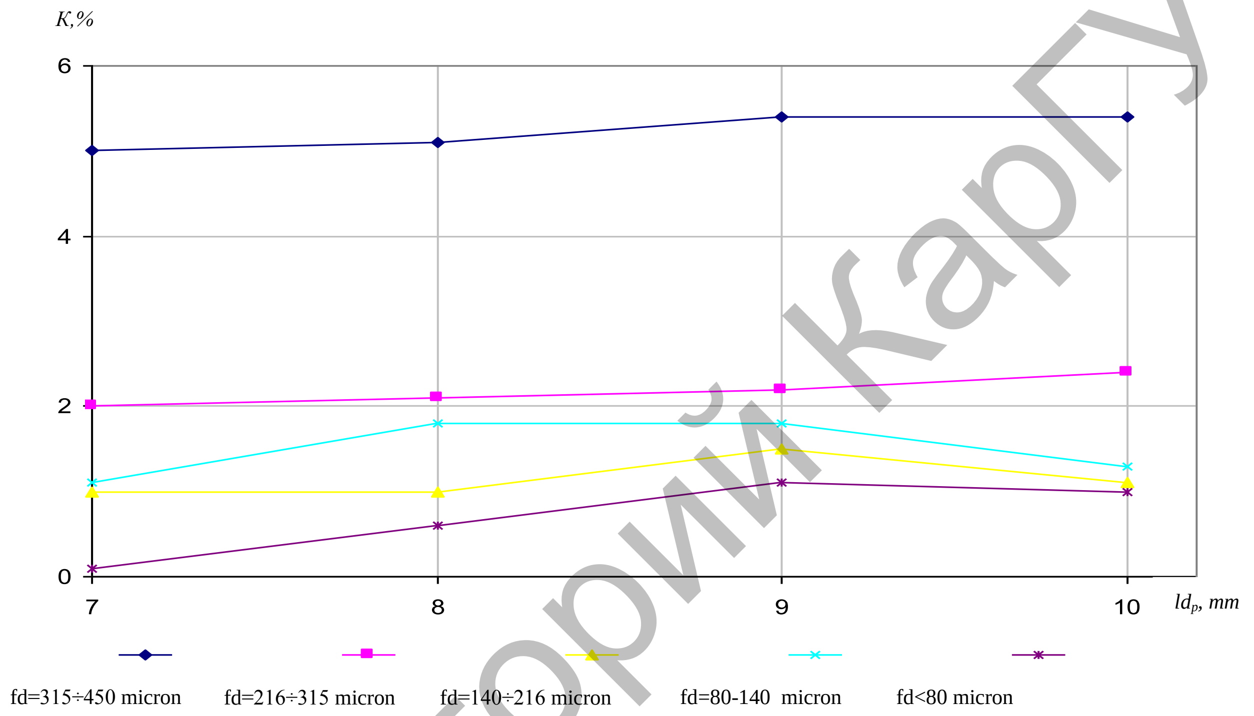


Fig.2. The working cell designed for grinding: 1- working cell cover, 2 - electrode of positive polarity, 3 – metal rod of negative polarity.

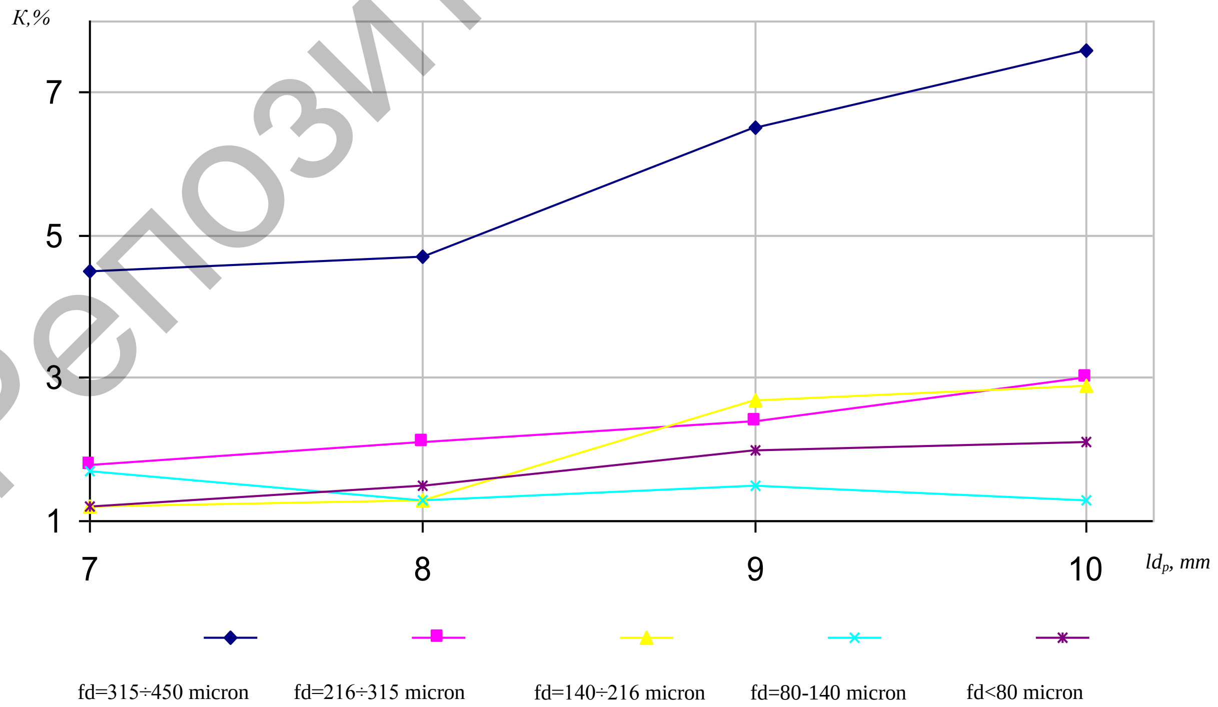
In the experiments the optimal parameters of coal grinding at different electrical parameters of electric hydro-pulse plant were determined.

In Figure 3 (a, b, c) dependency graphs of the degree of grinding on the inter-electrode distance for different capacitance of the capacitors are shown. Coal processing time t = 3 minutes, the coal fraction of diameter d = 8 mm, distance of the triggered spark gap l_d = 7 mm.

In Figure 3 (a) for the size of coal fraction d = 8 mm the distance between electrodes varied l_d = 7, 8, 9, 10 mm. The graph shows that at the inter-electrode distance l_d = 7 mm and the capacitance of the capacitor C = 0.25 μF the number of fractions of the diameter d_f <80 microns is 0.1%, and at the inter-electrode distance l_d = 10 mm, the number of fractions of the diameter d_f <80 microns, is 1%.



a)



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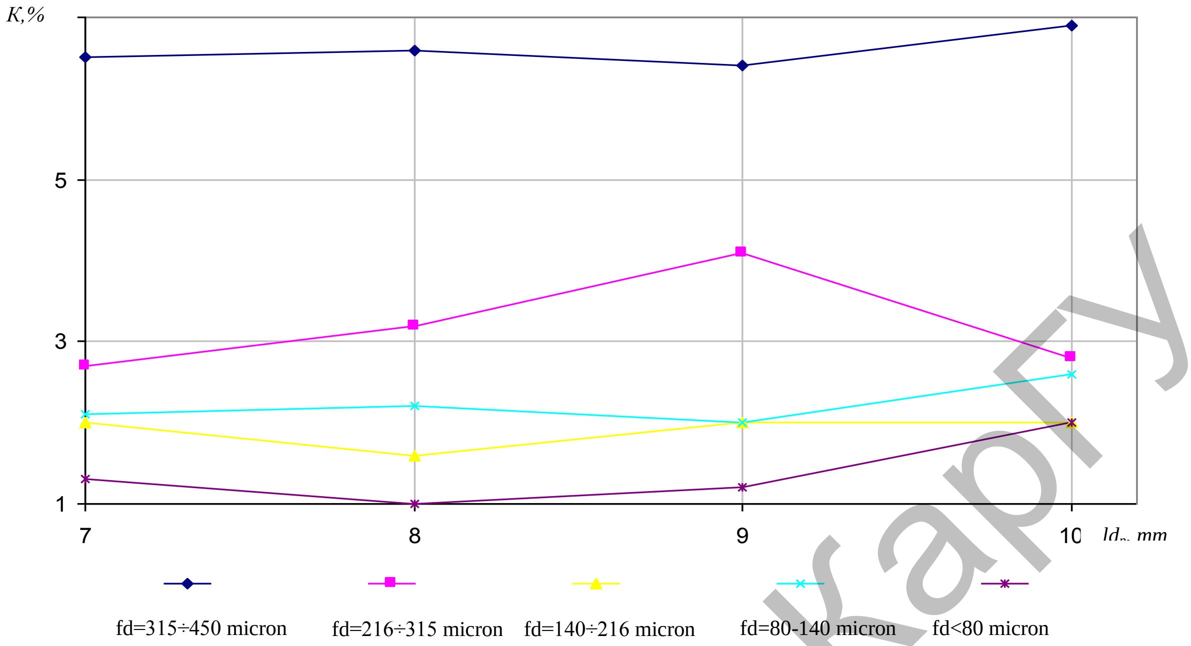

c)

Fig.3. Dependency graphs of the degree of grinding on the inter-electrode distance for the capacitance of capacitors C = 0.25 (a), 0.5 (b), 0.75 (c) μF.

In Figure 3 (b) at the inter-electrode distance l_d = 7 mm and the capacitance of the capacitor C = 0.5 μF the number of fractions of the diameter d_f <80 microns, is 1.2%, and at the inter-electrode distance l_d= 10 mm the number of fractions of the diameter d_f <80 microns is 2.1%. At the capacitance of the capacitor C = 0.75 μF and the inter-electrode distance l_d = 7 mm (fig. 3) the number of fractions of the diameter d_f <80 microns is 1.3%, and at the inter-electrode distance l_d = 10 mm the number of fractions of the diameter d_f <80 microns is 2%.

Here you can also see that at greater distance between the electrodes the number of fractions of small size increased significantly. This can be explained by the fact that as the inter-electrode distance increases, the energy of electro-hydraulic impact rises, and consequently the efficiency of grinding increases.

Analyzing the obtained results, we can conclude the following: the optimal parameters for grinding coal to fractions of d<80 microns are the inter-electrode distance l_d = 10 mm, the operating voltage of an energy accumulator is within 30 kV and the capacitance of the capacitor battery is 0.75 μF.

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Article accepted for publication 19.09.2012