Influence of hydrothermal treatment on inductance of water–peat suspension

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Abstract. The influence of hydrothermal carbonization on electrochemical properties of water–peat suspension was studied. It was found that the suspension acquires property of electrolyte when produced by hydrothermal carbonization, due to the washing out a part of the mineral component and possibly a partial conversion of the organic part.

Hydrothermal carbonization or “cold charring” is a process of coal production from biomasses of different origin. In this connection, the plant biomass attracts a special attention because it can be considered as a renewable raw material for energy and chemicals production. The main product of the reaction is a solid carbon material (“biocoal” or “hydrocoal”) which is similar to anthracite in physical characteristics.

Hydrothermal carbonization proceeds at about 200 °C in aerobic conditions and in the presence of water [1]. The pressure is corresponding to saturated steam one at the temperature used and water is in subcritical conditions. Both yield and quality of hydrothermal carbonization products are strongly depended on raw material and reaction conditions (temperature, residence time, ash content, etc) [2]. To carry out the hydrothermal carbonization, water and peat are mixed carefully producing a suspension. The composition of the suspension changes under the influence of temperature and in time. A part of inorganic (and, perhaps, a part of organic) components of raw material are dissolved in water and change its electrochemical properties. This change can be an indicator for depth of peat conversion.

Electrochemical properties of water–peat suspension were studied to determine a possibility to use a physical instrument as an indirect indicator for chemical peat conversion. It was the main goal of investigation. For this purpose, the effect of temperature and duration of hydrothermal treatment on electrochemical properties of water–peat suspension was studied. Peat of the Borovskoe field (Novgorod region, Russia) was used as a raw material. Thermoanalyzer SDTQ600 was used to determine moisture content, ash and yield of volatile compounds of peat. Calorific value of the material was determined from elemental analysis. Elemental analyzer Vario MICRO Cube was used for this purpose. It was found that the original peat had the following characteristics: humidity of 34%, ash content of 9.3%, higher caloricity of 7500 kcal/kg, volatiles yield of 80%.

Suspension was prepared by mixing 100 g of peat and 1 l of mineralized water. The initial pH of the received suspension was 6.5. Citric acid was used as a catalyst to facilitate process of peat
conversion. It was added in an amount sufficient to decrease pH down to 4.5. Electrochemical properties of the peat–water suspension were determined at 100 °C every 15 min for 2 h. The universal LCL meter BK PRECISION 878 was used for measurements. It was founded that electric capacity of the suspension increased in time significantly (figure 1). In 2.5 h it grew three times as much. This can be explained by the growth in electrical conductivity due to the appearance an electric charge transferred by electrons and ions.
Figure 3. Influence of hydrothermal treatment duration on the dielectric loss tangent of the peat–water suspension.

Figure 4. Influence of hydrothermal treatment duration on the inductance of the water–peat suspension.

As expected, electrical resistance of the peat–water suspension decreased during hydrothermal treatment of peat (figure 2). Tangent of dielectric losses decreased also (figure 3). However, the reduction of these indicators was smaller in comparison with electric capacity. They decreased by half. Perhaps, this can be explained by the nature of ions formed.

Moreover, both of these indicators changed dramatically within the first hour of the treatment, than the fall slowed down considerably. Perhaps, it can be connected with washing
out of potassium and sodium salts from the raw material in the first hour of the treatment. The salts are responsible for the sharp increase of electrical conductivity of the peat–water suspension. Further changes in electrical characteristics of the suspension is probably associated with transformations of the peat.

The inductance of the suspension, the index characterizing a change in the magnetic field, increased twice as much in the first hour of the treatment (figure 4). Later it is almost not changed.

Thus, it was found that changes in electrochemical indicators occurred in the hydrothermal treatment of peat at 100 °C. The changes are caused by the appearance of electrolyte properties due to leaching of the part of mineral components and, possibly, a partial conversion of the organic part.

References
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