

## ELECTROHYDRAULIC EFFECT IN AQUEOUS-PLANT HETERODISPERSE SYSTEMS

### III. A STUDY OF THE COMPOSITION OF THE SOLID PHASE AND THE AQUEOUS PHASE

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*By changing the conditions of the electrohydraulic treatment of aqueous plant heterodisperse systems comparatively high degradation of the lignin component of plant tissue has been achieved. In addition to free monosaccharides, their reduced forms have been detected in the aqueous phase.*

The present paper gives the results of the electrohydraulic treatment (EHT) of aqueous plant heterodisperse systems under conditions differing from those described previously [1]. In order to achieve a greater depth of degradation of the lignin component, the number of electrohydraulic shocks (EHSs) was increased from 50 and 100 to 500 and 1000, with a previously stored energy of 500 and 2500 J in a single discharge. For this purpose, some of the experiments were performed in hydrogen peroxide, since the interaction of the latter with lignin leads to the formation of products with a high degree of degradation [2].

As a result of EH treatment the amount of plant material decreased to 25-30% (Table 1), which is greater than for the utilization of the plant in variants of the experiment with up to 50 and 100 EHSs. The considerable consumption of plant material and the small amount of water-soluble substances found confirmed the hypothesis put forward previously that during EH treatment there is a breakdown of ether-extractable substances (EESs) and of carbohydrates to gaseous products the amount of which it is not possible to determine [1, 3].

Under the changed conditions of the EH treatment, the amount of EESs, suspended particles, and carbohydrates was greater than in [1]. Consequently, the increase in the number of shocks and in the energy stored in single charge, and also the change in the nature of the liquid phase led to a greater degradation of the main components of the plant material, especially lignin (Table 2).

It be seen from Table 2 that the increase in the number of shocks led mainly to a considerable decrease in the amount of lignin to a minimum value of 15.5% under the action of 500 EHSs on the system with cottonplant stems. With an increase in the number of EHSs to 1000 the amount of lignin proved to be considerably greater, which can be explained by the possibility of polymerization processes.

It must be mentioned that the performance of the process in hydrogen peroxide led to a considerable decrease in the amount of lignin in all cases (samples 3—5). An increase in the amount of stored energy also affected the destruction of the lignin in the plant material, and when  $H_2O_2$  was used as the liquid phase even a slight action of EHSs on the heterodisperse system led to a considerable fall in the amount of lignin (Table 2, sample 5).

The fractions of phenolic substances obtained by the separation of the EESs from each sample were analyzed by GLC. Phenol, guaiacol, *p*-hydroxyphenylethane, vanillyl alcohol, guaiacylpropane, guaiacylpropane, guaiacylpropane, guaiacylpropane-1-ol, *p*-hydroxyphenylpropane, guaiacylpropane-1-ol, *p*-hydroxyphenylpropane-3-ol, and guaiacylpropane-3-ol were identified, i.e., substances belonging to two types of phenylpropane structural units of lignin — the *p*-coumaryl and the guaiacyl. The absences of substances of the syringyl type indirectly indicated the occurrence of demethylation during the EH treatment. Phenol, guaiacol, guaiacylpropane, *p*-hydroxyphenylpropane-3-ol, and guaiacylpropane-3-ol predominated among the phenolic substances.

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TABLE 1. Results of the EH Treatment of Aqueous-Plant Heterodisperse Systems (in percentage of the total amount of plant material)

Sample	EHSs/ energy	Medium	Amount			
			solid res.	susp. particles	EESs	Carbohydrates
1. Cottonplant stems	500/500	H <sub>2</sub> O <sub>2</sub>	70.0	1.6	0.3	0.2
2. "	1000/500	H <sub>2</sub> O <sub>2</sub>	68.8	1.9	0.5	2.2
3. "	50/2500	H <sub>2</sub> O <sub>2</sub>	68.0	1.8	0.5	0.4
4. "	100/2500	H <sub>2</sub> O	68.8	1.9	0.3	0.4
5. Kenaf chaff [1]	100/500	H <sub>2</sub> O	85.5	0.5	0.2	0.4
6. "	1000/500	H <sub>2</sub> O	75.2	1.3	0.3	0.2

TABLE 2. Amount of Komarov Lignin in the Solid Residue, %

Sample	Number of ESSs	Komarov lignin
1. Cottonplant stems	0	28.8
2. " [1]	100	28.2
3. "	500	15.5
4. "	1000	21.7
5. *	50/2500	20.3
6. *	100/2500	25.1
7. Kenaf chaff	0	26.7
8. " [1]	100	24.7
9. "	1000	24.6

\*In the other cases, not marked by an asterisk, the amount of stored energy was 500 J.

The aqueous phase after the extraction of the EESs and the separation of the suspended particles contained carbohydrates. To determine the nature of the carbohydrate fraction we precipitated the polysaccharides with ethanol and subjected them to acid hydrolysis. Paper chromatography of the hydrolysates of all the samples (1-5) revealed the presence of glucose, arabinose, sorbitol, and an unidentified spot of uronic acids.

Thus, under the changed conditions of the EHE a partial reduction of the free monosaccharides was observed.

## EXPERIMENTAL

Stems of a cotton plant of the Mexicanum variety and chaff consisting of the woody part of kenaf stems were investigated. The plant raw material after extraction with alcohol—benzene (1:2), washing with hot water, and drying was used for the EH treatment on a ÉGU-5S apparatus created in the Siberian Institute of Terrestrial Magnetism, the Ionosphere, and the Propagation of Radio Waves (Irkutsk), with a series of from 50 to 100 EHSs having prestored energies of 500 and 2500 J and with up to 500 and 1000 EHSs with stored energy of 500 J in a single discharge. Water and a 5% solution of hydrogen peroxide (1000 ml) were used as the liquid phase, and the amounts of plant material were 60 and 100 g.

The separation of the EESs was done as in the scheme of [1], and the amount of Komarov lignin was determined by the procedure of [4].

The GLC analysis of the phenolic products was conducted on a Chrom-41 instrument. Conditions of separation: glass column 3 mm × 2.5 m filled with 15% of Apiezon L on Chromaton NAW-DMCS (0.16-0.20 mm) at 180-205°C and a rate of flow of carrier gas (helium) of 35-40 ml/min. Temperature of the evaporator 230°C.

The carbohydrate fractions, after being dissolved in a small amount of water, were precipitated with 5-10 ml of ethanol. The precipitate of polysaccharides was separated off by centrifugation, washed with alcohol and with acetone and dried over  $P_2O_5$ . The acid hydrolysis of the polysaccharides was performed with 2 N sulfuric acid in sealed tubes at 100°C for 8 h. The hydrolysates were neutralized with  $BaCO_3$ , deionized with KU-2 cation-exchange resin ( $H^+$ ) evaporated to a volume of 1.0 ml, and studied by PC. The solvent system used consisted of butanol, pyridine, and water and the revealing agents were acid aniline phthalate and Bromophenol Blue; FN-11 paper.

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