



LIQUID WASTE OF ORGANOSOLVENT DELIGNIFICATION OF RAPE STRAW

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The rapid growth in consumption of various types of cellulose and paper products, as well as the absence of the necessary volume of raw materials for their production, necessitates the application of non-woods for the production of different cellulose-based materials. Different biomasses have been offered to obtain pulp, e. g. wheat straw [1], bamboo [2], rice straw [3], corn stalks [4], grass [5], sugarcane [6]. One of the sources of such raw materials can be the straw of rape which is cultivated for oil-rich seeds. Rape straw that is not used for the purpose of agriculture, can be considered as a promising alternative to wood for the preparation of pulp, production of cardboard and paper products [7].

Typical technologies of pulp production have a negative effect on the environment. The development for fundamentally new technologies for the production of cellulose is carried out in different directions, e. g. biological synthesis, enzymatic delignification and solvolytic delignification. Solvent pulping is characterized by a lower temperature of the process and much shorter time in comparison with traditional [8].

The aim of the work was to investigate the composition of liquors after delignification of rape straw with peracetic acid.

Straw of rape (the content of cellulose, lignin, pentosans, wax and resins, ash was 37.7%, 26.4%, 29.6%, 3.6% and 7.2%, respectively), was used as a raw material. The delignification was carried out at different solid:liquor ration (5–9:1) at the temperature range from 70 to 90 °C during 120 min. The concentration of peracetic acid was 10%.

As can be seen from the data in Fig. 1, the increase in temperature leads to an increase in the amount of dissolved substances, while the efficiency of delignification decreases slightly. At the same time, the increase in temperature results in an increase in the dry residue because of the intensification of the process of removal of different extractive substances, lignin, polysaccharides and mineral substances from the raw material. The ash content decreases.

The ratio of solid:liquor, which effects the nature of diffusion processes in biomasses during delignification, is also an important factor of the delignification. To study the influence of this parameter on composition of spent liquor, a series treatment of rape straw with a solution of peracid of 10.0% was done during 120 min. The temperature of the process was 90 °C. The data in Table 1 show that pulping at 5:1 solid:liquor ratio allows to obtain lower amount of dissolved components resulting in low content of dry residue in spent liquor because of an incomplete delignification of rape straw. Diffusion restrictions on the transfer of peracetic acid from the pulping solution to the

intercellular space of the biomass leads to inhibition of the oxidation of lignin during delignification. The diffusion of the fragments of oxidized lignin from straw into the spent liquor is also complicated.

Spent liquor after rape straw organosolv delignification with peracetic acid at 9:1 solid:liquor ration, at the temperature of 95 °C and during 120 min was used for detailed investigation of chemical composition with the application of high-performance liquid chromatography using the system Agilent Technologies 1200 series (Santa Clara, CA, USA) with the column ICSep ICE-COREGEL 87H3.

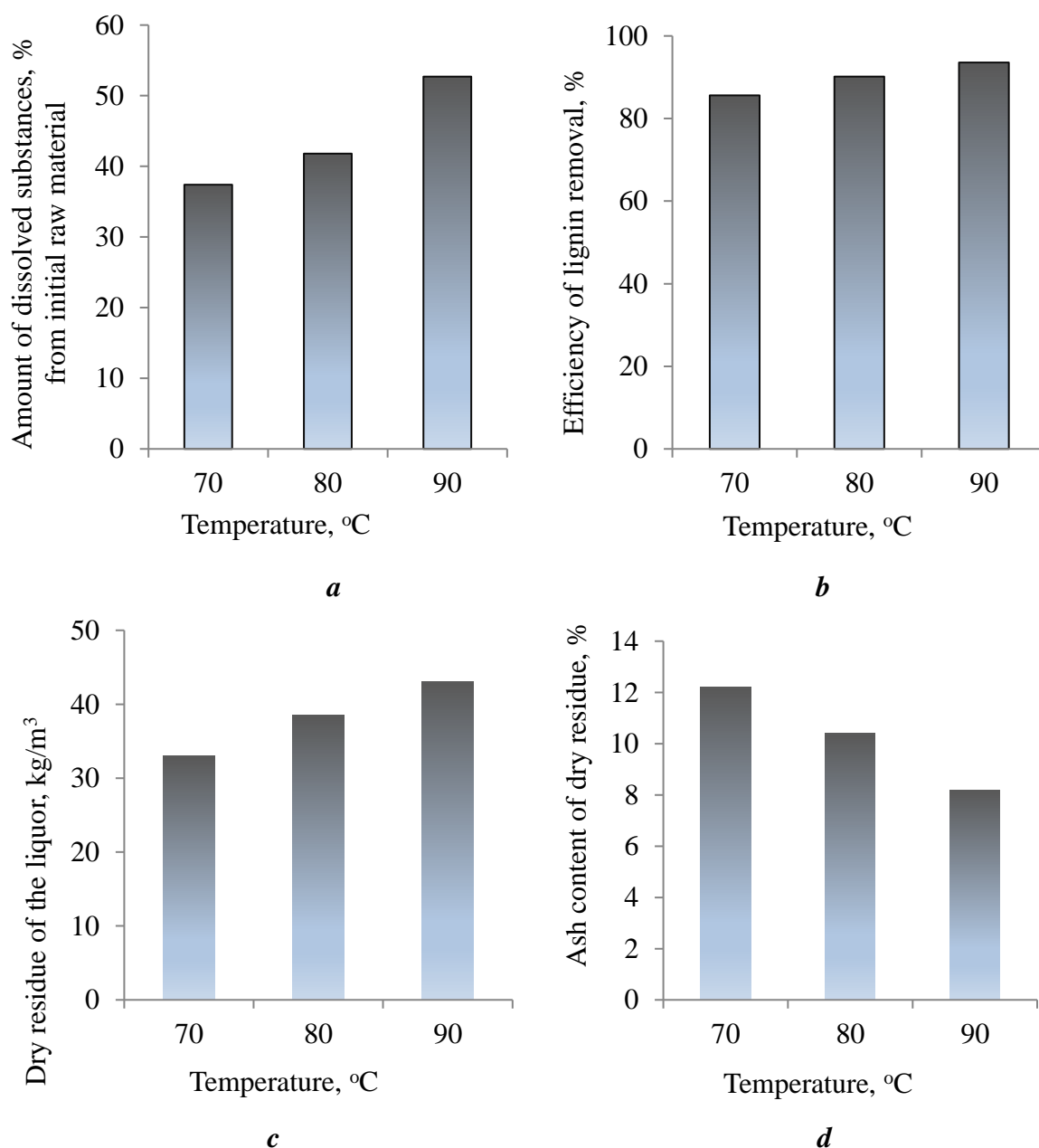


Figure. Effect of temperature of the straw peracetic treatment on amount of dissolved components (a), efficiency of lignin removal (b), dry residue of the liquor (c) and ash content (d) of dry residue

Table 1.

Effect of the solid:liquor ratio on the efficiency of rape straw delignification

Solid:liquor ratio	Amount of dissolved components, % from raw material	Efficiency of lignin removal, %	Dry residue, kg/m ³	Ash, %
5:1	46.1	89.4	39.9	14.5
7:1	52.8	93.6	43.2	8.2
9:1	60.3	96.6	55.1	3.9

During oxidative-organosolv treatment of rape straw with peracetic acid during 120 min, spent solution is characterized by a content of dry residue of 55.6 kg/m³. The obtained results indicate that during delignification process, peracetic acid is completely spent on the oxidation reactions of the raw material components. As a result, spent liquor enriched in sugars (Table 2). At the same time, the spent liquor contains a significant amount of acetic acid (723 g/l), which is appropriate to regenerate and return to the process to ensure the principle of resource saving.

Table 2.

Characteristics of the spent liquor after organosolv delignification of rape straw

Components, g/l	Content
Glucose	1,3
Xylose	6,7
Galactose	0,13
Arabinose	-
Mannose	0,18
Formic acid	2,2
Furfural	5,6
Hydroxymethylfurfural	1,7
Levulinic acid	4,0

Obtained spent liquor can be used for further processing with the application of evaporation stage. The regenerated distillate (acetic acid) can be returned and used for delignification, and the cubic residue can be used for precipitation of lignin, which can be used in the production of different goods, e. g. phenol-formaldehyde resins, for chemical processing into valuable chemicals, e. g. phenolic products, also as a filler of various plastic and in other directions.

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