

## **IMPACT OF COMPLEX HYDROMECHANICAL TREATMENT ON THE SIZE OF PARTICLES OF PLANT RAW MATERIALS IN THE FUEL ETHANOL TECHNOLOGY**

Oleksandr Obodovych, Dr. Sci. (Engin.)<sup>1</sup>, Prof., Yurii Bulii PhD (Engin.)<sup>2</sup>, Vitalii Sydorenko, PhD (Engin.)<sup>1</sup>, Parchenko Volodymyr<sup>1</sup>, Khomenko Valentyna<sup>1</sup>

**<sup>1</sup>Institute of Engineering Thermophysics of NAS of Ukraine**

**<sup>2</sup>National University of Food Technologies**

**Abstract:** The impact of the pulsation frequency of the working unit of the rotor-pulsation apparatus on the particle size of aqueous dispersions of wheat straw was considered. It was determined that increasing the pulsation frequency from 1 to 3 kHz reduces the number of cycles from 42 to 30. When changing the pulsation frequency from 1 to 5 kHz, the number of cycles decreases to 27.

**Анотація:** Розглянуто вплив частоти пульсацій робочого вузла роторно-пульсаційного апарата на розмір часток водних дисперсій соломи пшеничної. Визначено, що збільшення частоти пульсацій від 1 до 3 кГц кількість циклів зменшується з 42 до 30. При зміні частоти пульсацій від 1 до 5 кГц кількість циклів знижується до 27.

**KEYWORDS:** FUEL ETHANOL, PRETREATMENT, GRINDING, HYDROMECHANICAL PROCESSING, REACTOR MIXER.

**КЛЮЧОВІ СЛОВА:** ПАЛИВНИЙ ЕТАНОЛ, ПОПЕРЕДНЯ ПІДГОТОВКА, ВИДАЛЕННЯ ЛІГНІНУ, ІМПУЛЬСИ ТИСКУ, РЕАКТОР-ЗМІШУВАЧ.

The main disadvantage of ethanol production from lignocellulosic raw materials is the high cost due to the presence of hemicelluloses and lignin [1]. Considering the peculiarities of structural and chemical factors that determine its resistance to the action of enzymes, a necessary stage in the technology of obtaining ethanol for the next generation is the stage of pretreatment for hydrolysis [2]. In recent years, given the relevance of the development of alternative energy, the number of research works

devoted to the impact of key processing factors, particularly the size of raw material particles, on the results of hydrolysis and the subsequent stage of alcohol extraction has increased. During processing in rotary reactors based on centrifugal pumps, the raw material is subjected to additional impact of thermophysical factors, which contribute to a further increase in the degree of dispersion of the raw material, increasing the specific surface area of the cellulose material [3].

The aim of the study is to determine the impact of the complex of thermophysical phenomena of hydromechanical processing on the size of lignocellulosic materials during their pretreatment for hydrolysis in the technology of fuel ethanol.

Materials and methods. Experiments were carried out on wheat and corn straw with a particle size  $\leq 1$  mm. The processing of the aqueous dispersion of straw was carried out on a heat and mass exchange unit with a rotor-pulsation apparatus as a reactor-mixer. The determination of the granulometric composition of straw was carried out by the method of sieve analysis.

The processing conditions were as follows: solid/liquid ratio 1:10; processing duration 1 ... 50 cycles; flow shear rate  $20 \cdot 10^3 \text{ s}^{-1}$  and pulsation frequency 1 ... 5 kHz.

When processing an aqueous dispersion of wheat straw in a mixer reactor with a pulsation frequency of 1 kHz, 42 cycles are required to achieve a particle size of 100% less than 0.8 mm. When the pulsation frequency is increased from 1 to 3 kHz, the number of cycles decreases to 30 (i.e.  $\approx 30\%$ ). When the pulsation frequency is changed from 1 to 5 kHz, the number of cycles decreases to 27 (i.e.  $\approx 35\%$ ).

### **Conclusion:**

The obtained data indicate that the processing of aqueous dispersions of plantraw materials in rotary reactors based on centrifugal pumps at the stage of pretreatment of plant raw materials for hydrolysis, which occurs after the stage of mechanical grinding of plant raw materials, leads to further grinding of raw material particles. It was determined that changing the operating parameters of the reactormixer, which is a rotor-pulsation apparatus in which the stage of pretreatment of raw materials for hydrolysis takes place, allows changing the dispersion of the processed raw materials. The optimal operating parameters for the selected design of the reactor-mixer were

found to achieve the maximum surface area of plant raw material particles, which contributes to the next stage of enzymatic hydrolysis in the technology of obtaining fuel ethanol.

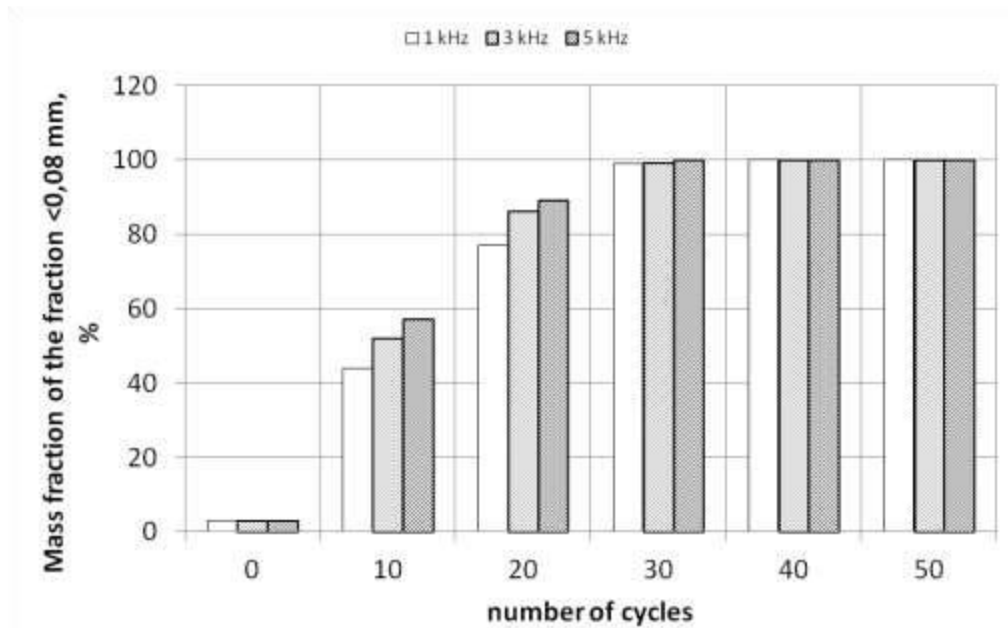


Fig. 1. Dependence of the mass fraction of the fraction of wheat straw particles less than 80 microns on the number of processing cycles and the frequency of pulsations

#### Literature:

1. Ye Sun, Jiayang Cheng Hydrolysis of lignocellulosic materials for ethanol production: a review. *Bioresource Technology*. 2002. vol. 83, Issue 1. pp. 1-11, [https://doi.org/10.1016/S0960-8524\(01\)00212-7](https://doi.org/10.1016/S0960-8524(01)00212-7).
2. Zoghalmi A., Paës G. Lignocellulosic Biomass: Understanding Recalcitrance and Predicting Hydrolysis. *Frontiers in Chemistry*. 2019. 7. <https://doi.org/10.3389/fchem.2019.00874>
3. Bimestre, T.A., Júnior, J.A.M., Canettieri, E.V. et al. Hydrodynamic cavitation for lignocellulosic biomass pretreatment: a review of recent developments and future perspectives. *Bioresour. Bioprocess*. 2022. 9, 7. <https://doi.org/10.1186/s40643-022-00499-2>.