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# Intensification of Anaerobic Conversion of Wastewater and Sewage Sludge: Trends Analysis

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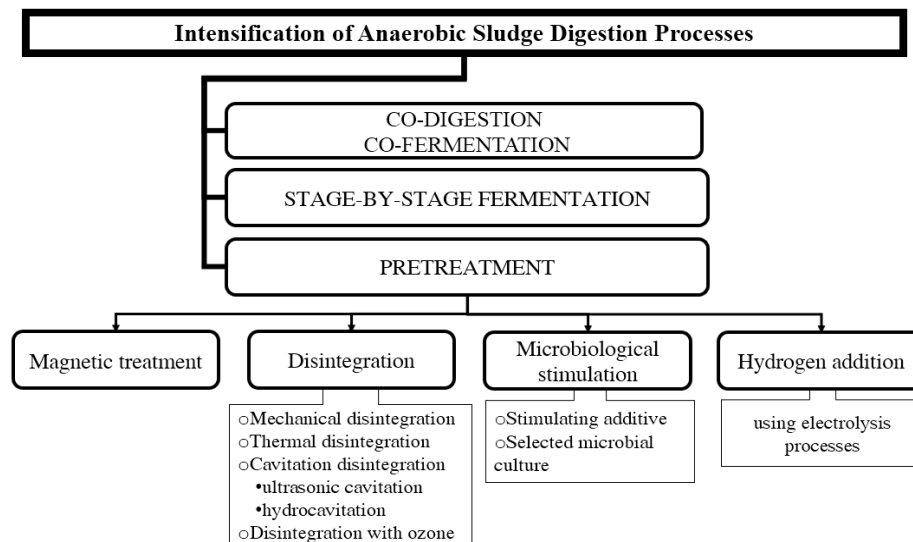
## ABSTRACT

The process of anaerobic digestion of wastewater and sewage sludge is characterized by low speed, therefore, a lot of attention is focused on the intensification of the bioprocess and increasing the biogas yield. Among the promising approaches of intensification of the biogas generation process are technologies of pretreatment that can increase the rate of biodegradability of organic substances and the use of mineral supplements/chemical by-products (Chernysh et al., 2018).

This study aims to review current trends in the stimulation of bioconversion of wastewater and sewage sludge components under anaerobic conditions, focusing on the theoretical justification of the combination of different methods of bioprocess intensification.

Placing disintegration processes before anaerobic digestion will result in a significant reduction of the digestion time and an increase in biogas production. The implementation of disintegration pre-treatment can considerably increase the biogas production and decrease the amount of volatile total solids in the digested sludge, as well as providing for a better sludge dewatering (Zubrowska-Sudol et al., 2017). According to Skorkowski et al. (2018), combined homogenizing mixing and cavitation disintegration using ultrasonic or hydrocavitation systems give better energy efficiency per unit than the same processes used separately. The benefit of ultrasonic disintegration as an effective method to intensify sludge digestion was confirmed by Tytla, 2018 case study. In this case, the additional ultrasonic disintegration treatment increases the total biogas production and decreases the total solids and volatile solids content (Zubrowska-Sudol et al., 2017). Treatment of mixed sewage sludge with the addition of enzymes before anaerobic digestion improves sludge decomposition and increases methane production. However, the high cost of enzyme production limits the use of enzymatic hydrolysis in industrial biogas plants (Parawira, 2012). The study Bagi et al. 2007 highlighted the importance of the syntrophic relationships between the microorganisms involved in biogas production and recognized the regulatory role of hydrogen production. The analysis of the intensification of biological wastewater treatment processes under aerobic and anaerobic conditions using a new generation of biostimulants has shown a different effect on microbial growth in sludge, depending on the concentration of biostimulants and the stage of microbial growth (Khabibrakhmanova et al., 2017). The addition of hydrogen to the sludge digestion process has no effect on the enrichment in the biogas composition, but instead significantly increases the amount of produced gas. It is related to an increase in biogas production by converting hydrogen to acetate and then converting it to methane (Martinez et al. 2019). The promising technological solutions for hydrogen saturation of sewage sludge could be electrotechnological devices based on electrolytic processes. The effect of magnetic fields on the microorganisms is controversial, but a well-calculated magnetic field strength can

promote the fermentation of anaerobic bacteria. The influence of magnetic fields on anaerobic digestion has been confirmed by experiments (Matos et al., 2020), it has been determined that too high or too low magnetic field induction, is not beneficial for anaerobic digestion of organic residues. The specific conditions of the magnetic field affect the activity of the microbial consortium. The magnetic field can accelerate the decomposition of the feedstock in the anaerobic digestion process and have a considerable role in the intensification of the biogas production process. Figure 1 shows a pattern of variations of anaerobic digestion intensification methods, which was formed based on the analysis of current trends in this field.



**Figure 1.** Methods of intensifying the anaerobic digestion of wastewater and sewage sludge

Thus, different combinations in pre-treatment and intensification of anaerobic digestion can be implemented, which increases the efficiency of the bioprocess. Experimental studies of the effect of magnetic treatment on the process of stimulation of different stages of anaerobic digestion will be carried out in future research.

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