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MONITORING ANAEROBIC DIGESTION EFFICIENCY AND SLUDGE UTILIZATION PRE-TREATMENTS VIA DIELECTRIC PARAMETER MEASUREMENT

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In multicomponent heterogeneous systems, where both chemical and structural changes occur during the process under investigation, the models used to calculate dielectric parameters cannot be applied with sufficient accuracy, therefore, dielectric parameters should be determined by measurements. The measurement of dielectric parameters enables indirect and non-invasive monitoring of the anaerobic digestion (AD) process.

Depending on the applied frequency, dielectric parameters can be sensitive to the changes in sludge composition (organic matter content, bound /free water ratio, microbial activity), making them suitable for evaluating disintegration degree in sludge pre-treatments; and, furthermore, the biodegradation efficiency and/or process stability during AD.

In our research, the dielectric behaviour of sludge from municipal and industrial wastewater sources was determined using an open-ended coaxial dielectric probe (DAK 3.5, Speag) connected to a vector network analyser (ZVL3, Rhode and Schwarz). The measurements were conducted in the frequency range of 200–2400 MHz both during pre-treatments (chemical, microwave, and combined treatments), and throughout the subsequent lab-scale batch mesophilic AD process.

During the pre-treatments, sludge disintegration degree was determined using COD fractionation methods, while in the AD process, the rate of organic matter reduction and the volume of produced biogas were monitored as well.

It was found that measuring the dielectric constant and loss factor within the frequency range of 200-600 MHz enables the identification of stages of the batch AD process and the determination of the optimal digestion time for maximising biogas production.

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