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sciforum-130331: Efficiency Assessment of Wastewater and Sludge Treatment using Dielectric Constant and Loss Factor Measurements

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In wastewater and sludge treatment processes, it is important to develop rapid and green measurement methods (i.e., with minimal chemical usage) that can be applied under industrial conditions, in addition to detailed analytical methods. Such methods could, for example, be used in the future for real-time efficiency monitoring. These requirements—non-destructive measurement, no chemical reagents required, and rapid determination—may be fulfilled by dielectric measurements. However, practical applications in the field of wastewater and sludge treatment remain limited.

In our research, an open-ended coaxial dielectric sensor (DAK3.5, SPEAG, connected to a Rohde & Schwarz ZVL3 VNA) was used to investigate the dielectric constant and loss factor within the 200–2400 MHz frequency range during various wastewater purification and sludge pre-treatment processes. Quantitative changes in organic pollutants in the wastewater were monitored by determining COD and BOD. During sludge treatments, changes in the solubility of organic matter (COD fractionation method) as well as aerobic and anaerobic biodegradability indicators (BOD and mesophilic biogas production) were also assessed.

The research results indicated that the decrease in organic matter concentration has a strong correlation with dielectric parameters in the 200–800 MHz frequency range. Moreover, it was found that, by jointly analyzing the frequency- and temperature-dependent dielectric behavior of wastewater of different origin and composition, characteristic differences in dielectric parameters could be observed—even for the same organic matter content. During sludge biodegradation, the critical frequencies corresponding to the maximum values of the dielectric constant and loss factor (within the 200–2400 MHz range) shifted towards higher frequencies, in accordance with the change in the organic matter removal efficiency and biogas production.

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