Pannon Egyetem

KONFERENCIA KIADVÁNY
CONFERENCE PROCEEDING

Műszaki Kémiai Napok 2024 Konferencia
Engineering Chemistry Conference
https://mkn.uni-pannon.hu

2024. április 16-18.

A kiadványt összeállította és szerkesztette: Balogh András és Klein Mónika

Támogatóink:

ABL&E–JASCO Magyarország Kft.
Laboratóriumi műszerek és berendezések forgalmazása

Complex Systems Monitoring
Research Group

ISBN 978-963-396-280-0

Műszaki Kémiai Napok 2024

Tudományos Bizottság

Elnök
Bélafiné Bakó Katalin

Tagok
Abonyi János
Chován Tibor
Guttman András
Gyenis János
Hancsók Jenő
Hodur Cecília
Horváth Krisztián
Járvás Gábor
Mika T. László
Modla Gábor
Németh Áron
Németh Sándor
Pethő Dóra
Szalai István
Szépvölgyi János
Varga Csilla
Varga Tamás
Vonderviszt Ferenc

Szervező bizottság

Titkár:
Klein Mónika

Dielectric monitoring in wastewater and sludge treatment processes

Dielektromos monitoring módszerek a szennyvíz és iszapkezelési eljárásokban

Sándor Beszédes, Zoltán Jákói, Ákos Fazekas, Tünde Baló, Balázs Lemmer

University of Szeged Faculty of Engineering Department of Biosystems Engineering
6725 Szeged Moszkvai krt. 9., Hungary

Summary

The efficacy of pollutant removal and/or transformation at each stage of the wastewater treatment process significantly affects the capacity and he overall efficiency of wastewater purification technologies. Variation and fluctuation in the composition and volume of industrial wastewater often necessitate the implementation of more specific treatment processes, compared to that of applied for municipal effluents.

Regardless of the origin, and composition of wastewater, and the treatment processes, there is a need to apply rapid measurement and data processing methods which can be applied for real effluents, as well. Preferably, these methods should be non-destructive and have minimal chemical and energy need (i.e., environmentally friendly), enable the real-time monitoring of pollutant removal efficiency.

The capacity and economy of wastewater treatment technologies are influenced by sludge treatment processes, as well. In recent decades, recovery techniques utilising the whole sludge material stream or selective extraction of individual components have come into the limelight, aligning with the principles of circular economy. Consequently, there is a demand for the development of methods for fast estimating of sludge composition, monitoring and predicting in-process the efficiency of sludge treatment processes. Monitoring and control methods for biological utilization processes can necessitate specific measurement techniques without disrupting the ongoing processes.

For these purposes, methods based on the determination of dielectric parameters are potentially suitable, but information on the dielectric behaviour of wastewater and sludge and practical experience with the measurement of these parameters are not yet available in details.

Therefore, in our research, dielectric constant and dielectric loss factor parameters -that determine the dielectric behaviour of the materials- of wastewaters from different origins (municipal, meat, dairy, sugar, high oil contented effluents) were measured in the frequency range 200-2400 MHz using an open-ended coaxial probe (Speag DAK 3.5 connected to Rohde&Schwarz ZVL-3 type VNA).

The organic matter removal efficiency was characterized by the change of chemical oxygen demand (COD). The changes in composition, structure and biodegradability in sludge treatment and recovery processes were investigated by the disintegration degree, biochemical oxygen demand (BOD5) parameters and batch mesophilic anaerobic digestion (AD) tests, respectively.

Our research results have demonstrated that the organic matter removal in municipal wastewater treatment technology (ca. 85% COD removal, using two stage processes) correlates strongly with the change of dielectric constant. In continuous flow thermal and microwave assisted alkaline sludge treatment processes have been verified that changes of disintegration degree, the organic matter solubilization (SCOD/TCOD) and the aerobic biodegradation index (characterized by BOD/TCOD) can be monitored by dielectric constants measured at the frequencies of 300 MHz and 2400 MHz.

By analysing the changes in the dielectric behaviour of sludge during anaerobic digestion (AD), it can be concluded that biogas production, i.e., the efficiency of biotransformation, can be monitored by measuring the dielectric constant and dielectric loss factor within the frequency range of 200-2400 MHz.

The critical frequency for an order of magnitude increase of the dielectric loss factor shifted towards higher frequency ranges as the fermentation process (organic matter decomposition) progressed. In the lag and log phase of the batch anaerobic digestion process, the dielectric constant showed a decreasing trend in the frequency range of 200-1200 MHz, correlating well with the organic matter degradation.

Acknowledgements:
The research is financed by National Research, Development and Innovation Office FK 146344 project. Beszédes S. is grateful for the financial support of Bolyai János Research Scholarship of the Hungarian Academy of Sciences (BO/00161/21/4).