

POTENTIAL APPLICATIONS OF DIELECTRIC MEASUREMENTS IN BIOMASS UTILIZATION PROCESSES

Sándor Beszédes, Zoltán Jákói, Laura Haranghy, Cecilia Hodúr

University of Szeged Faculty of Engineering Department of Biosystems Engineering

beszedes@mk.u-szeged.hu

ABSTRACT

Utilization of biomass by biological processes (enzymatic hydrolysis and fermentation of lignocellulosic biomass, anaerobic digestion) and other conversion methods (such as, thermochemical conversion) needs appropriate process control. In biological utilization of biomass, fast and non-destructive methods are needed to detect the physicochemical changes and the optimal end-point of the process. With the development of sensor technology dielectric measurements can answer for these challenges.

In our research, the dielectric behaviour (dielectric constant and loss factor) was investigated by a Speag DAK 3.5 open-ended coaxial line dielectric probe connected to ZVL-3 vector network analyser (VNA, Rohde&Schwarz) during enzymatic saccharification of plant derived biomass; ethanolic fermentation of preliminary hydrolysed lignocellulosic biomass (corn cob residue); and disintegration of primary wastewater sludge before anaerobic digestion in the frequency range of 200-2400 MHz. Cellulose hydrolysis, sugar conversion/ethanol production, and organic matter degradation was also monitored by routine analytical methods (photometric reducing sugar assay; refractometric ethanol determination; photometric chemical oxygen demand measurement).

Experimental data indicates that the degradation of organic matters of cellulosic biomass and wastewater sludge can be monitored with high precision by the dielectric constant at the frequency range of 200-900 MHz. Nevertheless, dielectric loss factor determined in the frequency range of 300-500 MHz was the most sensitive and appropriate dielectric parameter to monitor and predict the sugar/ethanol conversion yield. Our results verified the accuracy of open-ended coaxial dielectric probe for biomass contented suspensions and fermentation broth; and the applicability of dielectric measurements for detection of biomass degradation processes.

Keywords: dielectric parameters, biodegradation, enzymatic hydrolysis, biomass, process monitoring

Acknowledgements: The research is supported by the UNKP-21-5- SZTE-556 New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research Development and Innovation Fund. The authors thank the support of the János Bolyai Research Scholarship of the Hungarian Academy of Sciences (BO/00161/21/4.)