Cumulative microbial biomass characterization of a 2-stage anaerobic bio-digester using ATR-infrared spectroscopy

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Infrared spectroscopy has been used for the monitoring of many biotechnological processes. In particular, the attenuated total reflection measurement technique is mainly employed for the analysis of solid and liquid samples from different bioreactors. In our study, the degradation of carbohydrate and its further conversion into biogas within a two-stage anaerobic fermentation process has been investigated. For improving the process stability, the biomass degradation processes of hydrolysis and acidification are separated here from the stage of methane production. There are several consecutive and parallel reactions, in which a close-knit community of different bacteria cooperate for the transformation of organic matter into biogas. The biogas mainly consists of methane, which is the energy carrier of interest, and CO_2. For the conduct and optimization of the bio-reaction processes, a continuous monitoring of the reactor broth media and the cellular material is essential.

Samples from the substrate container and the two-stage anaerobic fermentation reactor were drawn during several weeks for the analysis of substrate and reaction products such as carboxylic acids. Infrared spectroscopic measurements were carried out on both the centrifuged broth media and the organic matter found as suspension. The aqueous broth spectra were recorded with water absorbance compensation using a fiber-coupled diamond ATR-probe, whereas the cellular suspension material was studied as air-dried matter prepared on one of the faces of the micro-diamond prism, constituting the probe tip. The total concentrations of several carboxylic acids (mainly acetic, propionic and butyric acid) were determined from the aqueous phase spectra. Spectral changes in the whole microbial biomass, collected in parallel from the different bioreactor stages, have been manifested over a month period for the first time.

The anaerobic degradation process of organic matter is very efficient, but also rather unstable. For achieving a better process management, it is necessary to understand the interdependencies between biochemical variables such as the concentration of carboxylic acids, pH, buffer capacity of the broth media, the microbial biomass and its growth, which will be the subject of more detailed future investigations.

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