Session: Biofilm application

On-line monitoring of biofilm accumulation on graphite-polypropylene electrodes applicable in bioelectrochemical systems using a heat transfer sensor

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Bioelectrochemical systems (BES) are among the emerging technologies in the quest for green energy, utilizing electroactive (EA) biofilms growing on solid electrodes for the production of hydrogen, base chemicals or electricity from waste water. For the industrial applications of BES long-term stable operation are necessary, by avoiding too thick waste water biofilms leading to diffusion limitation of substrates to the EA biofilm. Thus, monitoring the biofilm accumulation on the electrodes using biofilm sensors for application of control strategies is desirable.

In this study a commercially available heat-transfer biofilm sensor was investigated and transferred to a carbonaceous material (C-PP) applicable as electrode material in BES. The on-line sensor is installed to the outside of a substratum, thereby monitoring of the biofilm accumulation *in-situ* and non-invasively. For the comparison to the default sensor unit on a stainless-steel pipe (SST), the sensor was integrated to identical C-PP pipes and flow cells with a flat C-PP substratum. The sensor units were installed into a recirculatory system for the cultivation of wastewater biofilms under controlled turbulent hydrodynamic conditions for two weeks. To evaluate the transferability of the sensors from stainless steel to C-PP, the accumulated biofilms were characterized gravimetrically and by means of optical coherence tomography (OCT). OCT imaging allowed for non-invasive daily monitoring of morphological biofilm parameters in the flow cells, that were correlated with the sensor signal to identify the sensitivity of the sensors on the respective materials and geometries.

The gravimetrical biofilm characterization showed similar characteristics of the biofilms accumulated on all three sensors. Furthermore, the results proved the transferability of the sensor from SST to the C-PP electrode material. At the expense of an inferior sensitivity approx. 50 µm³/(µm²·a.u.) for C-PP to 9 µm³/(µm²·a.u.) for SST, respectively. Interestingly, in the flow cells the sensitivity of the sensor drastically improved, due to the different heat transfer mechanism in the flat configuration of the substratum. The sensors integrated into the flow cells enhanced the sensitivity, enabling the monitoring of the biofilm accumulation in the range of approx. 1.5 µm³/(µm²·a.u.). Thereby, the sensor presents a viable method for the monitoring of EA biofilms on C-PP-electrodes with different geometrical configurations.