BIOINDICATORS AS A TOOL FOR MONITORING AND CONTROL BIOFILM REACTORS: A SIMPLIFIED APPROACH

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Abstract

The control of wastewater treatment plants requires an extensive monitoring programme based on physicochemical costly routine analysis. Microbial populations are well known indicators of operational conditions in biological reactors. This research was carried out by the CENTA and the University of Minho in the scope of the Erasmus programme. The aim of the work was the development of a simplified approach, based on biological indicators, for monitoring small biofilm wastewater treatment processes. In that regard, protozoa and metazoan were monitored at CENTA experimental plants - namely a trickling filter and a rotating biological contactor -, and correlated with influent wastewater and effluent composition. The relationship between wastewater performance and the microbiological composition of the biofilm was identified and assessed. Results indicate that a methodology based on the bioindicators provides useful data for process monitoring and control of small wastewater treatment plants, thus diminishing the associated costs of routine analysis and providing information when such analysis aren't easily available.

Keywords: biofilm, bioindicators, monitoring.

Introduction

Wastewater treatment equipments like rotating biological contactors (RBC) or trickling filters (TF) use attached biomass in the form of structured biofilms for wastewater depuration. Biofilms are structured by a scarce bacterial community, protozoa, metazoan and filamentous bacteria, showing complex symbiotic patterns. The microbiological analysis of the community composition constitutes a suitable tool for wastewater treatment diagnosis and assessment, and to some extent, it can be used instead of physicochemical analysis (which has some disadvantages, like being time-consuming and considerably expensive). Several works about bioindicators are developed using activated sludge. The Sludge Biotic Index (SBI) is based on the abundance and diversity of microorganisms communities, as well as on the difference between their sensitivity against the main environmental factors in the system (Madoni, 1994a). This study was carried out at the experimental wastewater treatment plant of Carrión de los Céspedes – Seville (Spain), where the attached biomass from both a trickling filter (TF) and a rotating biological contactor (RBC) was analysed.

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Methods

Besides the identification of protozoa, metazoan and filamentous bacteria in the biofilms of the RBC and the FT, the following analytical determination were carried out in samples of the reactors influent and effluent: COD, BOD_5, TSS, N-Kjeldahl, N-ammonia, N-nitric, total P, phosphates. The identification of the microfauna was based on methodologies reported elsewhere (Martín-Cereceda, 1996. Emasesa, 1997). In a final stage of analysis, the values of the measured parameters were statistically correlated using Principal Components Analysis (PCA), in order to obtain SBI values, which where used to evaluate the performance of the biofilm in both reactors.

Results and discussion

Results from the PCA analysis showed different relationships between the measured parameters. Table 1 presents an example of the correlation coefficients obtained for the relationships between functional groups of protozoa and metazoan, and the effluents physico-chemical parameters (showed for RBC samples). In this case, the best results for correlation coefficients were obtained for the free swimmers group. For the stalked ciliates, results showed also a good correlation for BOD_5 and TSS.

Table 1. Example of data for partial correlation coefficients between the physicochemical parameters and the microfauna functional groups in the RBC

	Physico-chemical Parameters						
Microfauna functional groups	**Superficial organic matter**	**BOD_5 (in)**	**BOD_5 (out)**	**DO (out)**	**TSS (in)**	**NO_3^- (in)**	**P_{total} (out)**
Free Swimmers	**0,94**	-0,32	-0,12	0,44	-0,21	**0,96**	0,35
Crawler Ciliates - Free Swimmers	-0,47	**0,72**	**0,72**	**-0,72**	0,54	-0,70	**-0,80**
Crawler Ciliates	**0,74**	-0,49	-0,18	0,41	0,01	**0,81**	0,35
Stalked Ciliates	-0,40	-0,63	**-0,82**	0,64	**-0,80**	-0,13	0,39
Metazoan	0,34	0,53	0,65	-0,62	**0,86**	0,14	-0,10

Legend: BOD_5 (in) and **BOD_5 (out)** – Biochemical Oxygen Demand in the system on the influent and effluent; **DO (out)** – Dissolved Oxygen on the system effluent; **TSS (in)** – Total Suspended Solids on the influent; **NO_3^- (in)** – nitric nitrogen on the influent; **P_{total} (out)** – Total Phosphorus at the system effluent.

In that scope, results indicate that the presence of these ciliates has a negative impact in regard to BOD_5.in the effluent. This result is in accordance with results presented by Martín-Cereceda for activated sludge systems (Martín-Cereceda, 1996). It was demonstrated that a negative value for the correlation coefficient between BOD_5 and the amount and diversity of stalked ciliates is a suitable indicator of a healthy performance of the process.

Conclusions

Based on the obtained results, the examination of the microbiological composition of the communities and the following determination of correlation coefficients showed consistence with operational data. In that scope, this bioindicators can be used as a suitable tool for the assessment of wastewater treatment performance in attached biofilms systems like rotating biological contactors.

References

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