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Environmental technology // Emissions

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TITLE:

Application of biofilm processes for advanced COD reduction in paper mill effluents

Background/Problem area

The residual COD level of biologically treated paper mill effluents is in the range of 100 to 500 mg/l. In some cases this level is too high and exceeds the environmental discharge limit values. Hence expensive advanced processes for further COD elimination like precipitation, oxidation or membrane processes are needed.

Biofilm processes, like MBBR (Moving Bed Biofilm Reactor) are often used as primary high loaded stage for aerobic biological treatment. Because of the potential of biofilms (bf) to afford slow growing microorganisms an opportunity to proliferate, this process should be able to increase the total COD elimination of aerobic biological processes.

Objectives/Research results

The aim of this project was to use bf processes as a second stage process for the enhancement of biological treatment of pulp & paper mill waste water. This was to be arranged by using bf's which incorporate microorganisms with a high elimination potential for slowly degradable organic substances.

Biofilms with increased COD reduction potential were to be identified and characterised. Samples of biofilms, which grow in waste water treatment plants (wwtp) under substrate restricted conditions (e.g. at the end of a cascade or at the outflow of the secondary clarifier) were investigated by static degradation tests to determine their potential for COD reduc-tion. Samples with a high potential were used to continuously test cultivate biofilms. The conditions for optimum immo-bilisation and operation were to be elaborated. Based on these results the operation conditions of an adapted biofilm proc-ess stage were derived.

At first a continuous 5 l-laboratory wwtp was equipped with a control unit to perform sequencing batch process which was to be used for breeding of adapted bf's on carriers and put in operation. Also the methodology of the static degradation test (Zahn-Wellens-Test) was adapted to low loaded conditions (COD values of 100 – 400 mg/l).

To characterise the elimination potential of slowly degradable substances by bf's comparative static degradability tests with activated sludge (as) and bf's from industrial wwtp's were performed. Samples of as, bf and biological treated effluent of 8 paper mills (5 deinking mills, 2 office paper mills, 1 integrated pulp&paper mill) were investigated. The results showed slightly higher degradation performances for bf's. In the case of deinking mill effluents residual COD respectively TOC reduction was increased by 5 – 10 %. So far bf have been operated as suspended cultures and therefore not under optimum conditions. Taking this fact into consideration the available results were very promising. The respirometric activity also showed higher values for bf's.

After the start up of the laboratory wwtp under substrate limited conditions the reactor was inoculated with a bf sample, which showed a high COD elimination potential and a special composition of microbial organisms (detected by gen-probes) During a trial period of 25 weeks no additional effect on COD removal was observed. After a repeated small dosage of easily degradable substances and addition of nutrients a 50% reduction of COD after 40 weeks of operation was measured. This reduction resulted from biological degradation by bf as well as physical processes like adsorption onto bf. The characterisation of the generated biofilm by molecular genetic methods showed a high diversity of organisms.

The last working steps dealt with the optimisation of the operation of the bf reactor and the elaboration of optimal operating parameters.

Application/Economic benefits

A further decrease of COD by these processes may lower the costs for the reduction of the discharged organic load. The available processes of advanced treatment are mostly expensive and often need special installations. In addition separate steps for the disposal or treatment of generated wastes are oftentimes required. The specific costs of COD-elimination by bf processes are generally lower then this of oxidation or membrane processes.

MBBR processes as second or final stage can be easily integrated in existing aerobic treatment stages of wwtp and are a cost effective alternative to advanced chemical and/or physical processes. Hence the treatment costs can be reduced, the economic competitiveness of the sme can be secured or the extension of production capacity is possible while still meeting the environmental limits.

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Remarks

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