Degradation of Chloroaromatic Compounds in a GAC Biofilm Reactor: Effect of Perturbations

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Chlorinated aromatic compounds are priority environmental pollutants (EC Framework Directive 76/64/EEC). We have isolated haloaromatic degrading bacterial consortia from the rhizosphere of the reed Phragmitis communis which inhabits a heavily contaminated environment in Northern Portugal. Consortium EST2 was selected for further studies as it was able to metabolise the widest spectrum of target substituted aromatic compounds. These compounds included nitrophenols, chlorophenols, benzene, chlorobenzene and mixtures of chloro- and nitrophenol and mono- and di-chlorophenols. The removal of compounds from culture media was monitored by HPLC and chloride liberation.

Consortium EST2 was used to establish a granular activated carbon (GAC) biofilm column for the degradation of a model target compound, 4-chlorophenol. The effect of heavy metal and nitrate addition on bioreactor performance was investigated. A tubular glass column was packed with GAC and inoculated with a 4-chlorophenol batch grown EST2 culture. Initially, the reactor was operated in a closed system mode in order to establish the biofilm on the GAC column. The reactor was subsequently run in continuous open mode operation to quantify 4-CP degradation in the reactor. This was determined based on the amount of chloride released into the recirculating vessel or effluent. Adsorption to GAC was quantified by measuring the amount of chlorophenol in the column outlet. Both adsorption and biodegradation occurred in the GAC column bioreactors, and 4-CP was never detected in the column effluent.

Different amounts of a priority heavy metal pollutant, chromium, were supplied to a GAC biofilm column previously established under similar operating conditions. During shock loadings of chromium (10 ppm) onto the column in continous mode, 0.05-0.1 mgCr/gGAC was adsorbed, and this did not affect 4-CP biodegradation. Twice the amount of chromium was adsorbed onto colonised GAC particles. In batch suspension cultures, EST2 was able to biodegrade 4-CP in the presence of Cr, in the tested range 1-5 ppm Cr, and only at the highest concentration an acclimation period occurred. The effect of nitrate addition was also examined. The binding of nitrate to GAC depends on the flow conditions, and in batch cultures nitrate did not affect 4-CP metabolism, at tested supplied concentrations up to 400 ppm.

The development and structure of the biofilm community was monitored using Scanning Electron Microscopy (SEM) and Confocal Laser Scanning Microscopy (CSLM). Mature biofilms had a network of channels and long void spaces, partially filled with exopolymer structures (EPS).