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Effect of Starvation upon Activity of Microorganisms Degrading 4-Chlorophenol

Iván Moreno-Andrade, Gopalakrishnan Kumar and Germán Buitrón*

Laboratory for Research on Advanced Processes for Water Treatment, Unidad Academica Juriquilla, Instituto de Ingenieria, Universidad Nacional Autonoma de Mexico, Blvd. Juriquilla 3001, 76230 Queretaro, Mexico

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The variation of the microbial activity during starvation of microorganisms degrading 4-chlorophenol was evaluated in a sequencing batch reactor. During the acclimation, a reduction in the degradation time and an increase in the specific degradation rate were observed. After the acclimation, the biomass was exposed to different starvation periods (8 to 36 h). The results showed that the starvation could decrease the microbial activity and composition. A reduction from 44 to 21% was observed on the specific removal rate, and from 35 to 26% on the specific oxygen uptake rate. The extension of the deacclimation of starved microorganisms was affected by the history of the culture. The effect of starvation on the degradation rate was less significant when microorganisms were starved, recovered and then starved again, than in the case where starvation is cyclically presented without a recovery period.

Keywords: Acclimation; Microbial activity; Starvation; SBR; 4-Chlorophenol.

INTRODUCTION

Biodegradation of a toxic substance using a biological process requires acclimation of the microorganisms, the key step to the assimilation of the compound. This occurs when the microorganisms are put in contact with toxic compounds in a favorable environment.[1,2] However, it has been shown that this acclimation is not permanent.[3] The exposition of the acclimated population to prolonged periods of starvation produces a decrease of the bacterial activity and even the death of some of them.[4] It has been found that in many biological wastewater treatment plants, large fluctuations are observed in the hydraulic and organic loadings due to weekly and seasonal fluctuations, wherein flows vary between weekdays and weekends producing starvation, i.e., periods without substrate in the reactor.[5]

For example, Arbuckle and Kennedy[6] found that activated sludge acclimated to degrade 4-chlorophenol (4CP) lost its ability when the compound was absent from the feed of the reactor (starvation period). It has been suggested that the lost in microbial activity is affected by the starvation period length, the type of compound, the culture history and the initial induction level.[7] Buitrón et al.[8] found a negative effect of starvation periods on 4CP degradation for an activated sludge in a sequencing batch reactor (SBR) system. In that study, the aeration was extended 20 to 23 hours after the toxic degradation had been completed. It was found that the degradation time has been increased 6 times (from 0.7 to 4.5 h) as a result of such a starvation period. This lost in microbial degradation capacity was attributed to a decline in both the enzymatic activity and the viability of the suspended cells. In this sense, it has been demonstrated that the exposition of a pure culture (*Pseudomonas aeruginosa*) to starvation produces a decrease in the viability and activity for the degradation of 4-chlorophenol.[9] Buitrón et al.[10] demonstrated that the starvation of *P. aeruginosa* during glucose degradation, not only decrease the cell viability and the microbial degradation rate, but changes in the cellular fatty acids was also observed. It was found that the *trans/cis* ratio of cellular fatty acids increased significantly as a result of bacteria starvation and can be used as an indicator of stress by starvation.[10]

Besides, other studies have examined the effects of pre-starvation on the survival of cells. In some cases an improvement of survivability has been reported, although other studies showed no effects of the starvation treatment.[11] Lopez et al.[12] demonstrate that in activated sludge, the endogenous process during long-term starvation enhanced biological phosphorus removal. It has been suggested that this inconsistency may have been due to the different starvation conditions used in these studies.[11] Watanabe et al.[13] showed that during long starvation times there exists a decrease in the population density, respiration rate, dehydrogenase activity and in the phenol-oxygenating activity that may affect the performance of a wastewater treat-

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* Corresponding author. Tel: +52 442 1926165; Fax: +52 442 1926185; E-mail: gbuitronm@ii.unam.mx

