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Effect of a Mixture of Phenol, O-Cresol, P-Cresol, and M-Cresol on the Nitrifying Process in a Sequencing Batch Reactor

Authors : Adriana Sosa, Susana Rincon, Chérif Ben, Diana Cabañas, Juan E. Ruiz, Alejandro Zepeda

Abstract : The complex chemical composition (mixtures of ammonium and recalcitrant compounds) of the effluents from the chemical, pharmaceutical and petrochemical industries represents a challenge in their biological treatment. This treatment involves nitrification process that can suffer an inhibition due to the presence of aromatic compounds giving as a result the decrease of the process efficiency. The inhibitory effects on nitrification in the presence of aromatic compounds have already been studied; however a few studies have considered the presence of phenolic compounds in the form of mixtures, which is the form that they are present in real context. For this reason, we realized a kinetic study on the nitrifying process in the presence of different concentrations of a mixture of phenol, o-cresol, m-cresol and p-cresol (0 - 320 mg C/L) in a sequencing batch reactor (SBR). Firstly, the nitrifying process was evaluated in absence of the phenolic mixture (control 1) in a SBR with 2 L working volume and 176 mg/L of nitrogen of microbial protein. Total oxidation of initial ammonium (efficiency; ENH4+ of 100 %) to nitrate (nitrifying yield; YNO3- of 0.95) were obtained with specific rates of ammonium consumption (qN-NH4+) and nitrate production (qN-NO3-) (of 1.11 ± 0.04 h-1 and 0.67 h-1 ± 0.11 respectively. During the phase of acclimation with 40 mg C/L of the phenolic mixture, an inhibitory effect on the nitrifying process was observed, provoking a decrease in ENH4+ and YNO3- (11 and 54 % respectively) as well as in the specific rates (89 y 46 % respectively), being the ammonia oxidizing bacteria (BAO) the most affected. However, in the next cycles without the phenolic mixture (control 2), the nitrifying consortium was able to recover its nitrifying capacity (ENH4+ = 100% and YNO3-=0.98). Afterwards the SBR was fed with 10 mg C/L of the phenolic mixture, obtaining and ENH4+ of 100%, YNO3- and qN-NH4+ 0.62 ± 0.006 and 0.13 ± 0.004 respectively, while the qN-NO3- was 0.49 ± 0.007. Moreover, with the increase of the phenolic concentrations (10-160 mg C/L) and the number of cycles the nitrifying consortium was able to oxidize the ammonia with ENH4+ of 100 % and YNO3- close to 1. However a decrease in the values of the nitrification specific rates and increase in the oxidation in phenolic compounds (70 to 94%) were observed. Finally, in the presence of 320 mg C/L, the nitrifying consortium was able to simultaneously oxidize the ammonia (ENH4+= 100%) and the phenolic mixture (p-cresol>phenol>m-cresol>o-cresol) being the o-cresol the most recalcitrant compound. In all the experiments the use of a SBR allowed a respiratory adaptation of the consortium to oxidize the phenolic mixture achieving greater adaptation of the nitrite-oxidizing bacteria (NOB) than in the ammonia-oxidizing bacteria (AOB).

Keywords : cresol, inhibition, nitrification, phenol, sequencing batch reactor
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