Sequential coupling of nitrification-denitrification for simultaneous removal of ammonium, *p*-cresol and sulfide

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Introduction. Industrial activities such as oil refining, chemical and paper manufacturing have generated wastewaters containing ammonium, sulfide and phenolic compounds with concentrations ranging from one to several hundred mg/L (Olmos et al., 2004). These compounds have been reported to cause environmental and public health damage. Nowadays, in order to remove nitrogen and carbonaceous compounds nitrification-denitrification process is commonly used. Simultaneous removal of *p*-cresol, ammonium and sulfide by sequential nitrification-denitrification process in the same reactor, and using aerobic granular sludge as inoculum has not been reported. The goal of this study was to evaluate the nitrification-denitrification process via "elemental sulphur" in order to biotransform *p*-cresol, sulfide and ammonium into CO_2, SO_4^{2-} and N_2, respectively.

Methods. Batch cultures were performed in stirred instrumented experimental units with working volume of 1.0L. Initial sludge concentration was of 3.0 g VSS/L. The air was continually supplied through the reactor liquid phase by using an air sparger at the bottom, reaching a DO concentration of 4.5mg/L. The bioassays were performed by duplicate at 25°C, 200 rpm and pH of 7.0. Culture medium was taken from Beristain-Cardoso et al. (2010). Initial concentrations spiked were 50 mg NH_4^+-N/L, 100 mg *p*-cresol-C/L and 100 mg S^{2-}/L. Nitrification had a duration of 9h, after that aeration was stopped and residual oxygen was removed by a helium gas flow. NO_3^-, NO_2^-, $S_2O_3^{2-}$, SO_4^{2-}, NH_4^+, N_2, N_2O, *p*-cresol and VSS were analyzed as was reported by Beristain-Cardoso et al. (2010).

Results. Fig. 1 shows the time course of nitrogenous, sulfurous and carbonaceous compounds consumption during the coupling of nitrification-denitrification process. Three aerobic respiratory processes were performed at the first 5 h, namely: nitrification, sulfide-oxidation and phenolic compound oxidation. After 9 h, aeration was stopped. The S^0 produced under nitrifying conditions was used after as electron donor to reduce NO_3^- to N_2 in the denitrification process. The global analysis of the coupled nitrification-denitrification showed that: ammonium, sulfide and *p*-cresol consumption efficiencies were above 98%. Soluble organic carbon was detected at lower concentrations (~3.00 mg C/L), suggesting that phenolic compound was mainly mineralized to CO_2. N_2O was transiently produced, but at the end of the batch studies it was completely reduced to N_2. The denitrification end products were SO_4^{2-} and N_2, with yields of 1.04 mg SO_4^{2-}-S/mg S^{2-} consumed and 1.03 mg N_2/mg NH_4^+-N consumed, respectively. Aerobic granular sludge showed metabolic capability to carry out two biological processes in the same bioreactor: nitrification and denitrification via "elemental sulfur" formation.

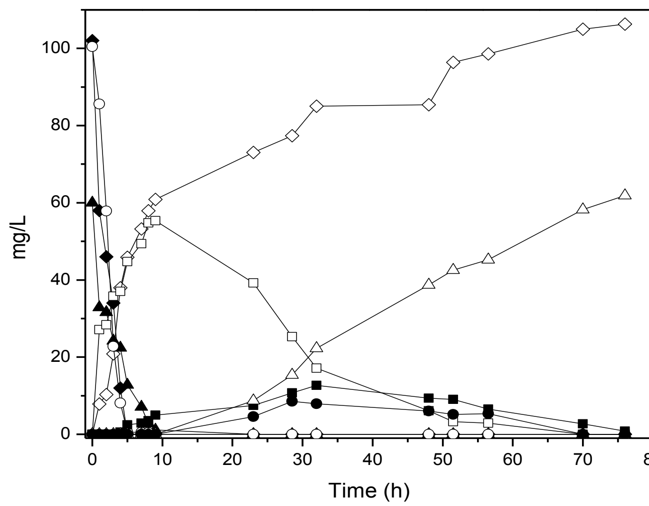

Fig. 1 Time course of *p*-cresol, sulfide and ammonium by nitrification-denitrification: (▲) NH_4^+-N; (♦) S^{2-}-S; (○) *p*-cresol -C; (□) NO_3^--N; (■) NO_2^--N; (●) N_2O-N; (Δ) N_2-N; (◊) SO_4^{2-}-S

Conclusions. In the sequential process of nitrification-denitrification; ammonium, sulfide and *p*-cresol were successfully removed, being the end products N_2, SO_4^{2-} and CO_2, respectively. The research work evidenced 1) metabolic capability of an aerobic granular sludge to nitrify and denitrify, and 2) that the use of one bioreactor with aerobic granular sludge might be a feasible technology to treat wastewaters of chemical complexity.

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