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PROYECTO FIN DE CARRERA

NITROGEN REMOVAL IN ANAMMOX BIOREACTORS

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ALUMNO: BEGOÑA GARCÍA LAPEÑA

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RESUMEN

In recent years, different biological processes have been developed to remove nitrogen from wastewaters. One of these processes is the Anaerobic Ammonium Oxidation process (Anammox) in which ammonium is oxidized to nitrogen using nitrite as oxidant. The anammox process was discovered in 1977 and presents may advantages compared to more conventional nitrogen removal processes as nitrification and dentitrification. Particularly important among these advantages are the lower energy consumption and no need for oxygen or external source of organic matter.

Knowledge of the main parameters that influence the activity of anammox bacteria is critical to optimize the process performance. The main objectives of this study are as follows: *1)* to investigate approaches to increase biomass retention in the anammox process in order to reduce the startup period; *2)* to study the kinetics of the process, and *3)* to investigate the toxicity of two important wastewater components (nitrite and H_2S). In this project, all these objectives have been study with the help of three different types of reactors.

Operation of a membrane bioreactor (MBR) for 300 days at a hydraulic retention time (HRT) of 1 d demonstrated that the system could reach a volumetric nitrogen removal of 26.4 mg N/L d with nitrite and ammonium removal efficiencies of 99 and 95%, respectively. Under these conditions the biomass reached a value of around 900 mg VSS/L. The biomass in the effluent cannot be measured because is practically zero, so the membrane bioreactor has a good biomass retention.

Batch tests were used to determine the kinetic of the process and the influence of pH and the toxicity of H_2S. There are different studies about the kinetics of the anammox process, but few have considered the simulatenous utilization ammonium and nitrite. Process kinetics was studied using a mathematic model based on Monod microbial growth kinetics. The kinetic parameters determined for anammox granular

sludge were: K_S NH_4^+ = 0.680 mM; K_S NO_2^- = 0.339 mM, and for anammox flocculent sludge (K_S NH_4^+ = 0.544 mM; K_S NO_2^- = 0.375 mM).

The pH value has a very significant impact on the activity of anammox bacteria. The anammox activity was almost constant in the pH range from 7.2 to 7.5 with a maximum activity at a pH of 7.3. Outside of this range, the anammox activity decrease considerably. Sulfide (H_2S), a wastewater contaminant commonly found in reducing environments, is highly inhibitory to anammox bacteria. A significant decrease in the anammox activity, up to 65%, in the presence of 0.5 mM of H_2S; however addition of stoichiometric levels of Fe^{2+} , a cation that forms very insoluble salts with sulfide, eliminated microbial inhibition.

Laboratory-scale upflow bioreactors were used to study the toxicity of the nitrite on the anammox process. Three continuous different reactors were operating for more than 120 and fed an influent containing 4 mM NH_4^+ and different concentrations of nitrite. Reactor 1 (R1) was fed with a stoichiometry nitrite-ammonium ratio (NO_2^-/NH_4^+ = 1.15), and considered the control to compare the results with the other two reactors. Reactor 2 (R2) had a 30% excess of nitrite (NO_2^-/NH_4^+ =1.64), and the reactor 3 (R3) had a 50% excess of nitrite (NO_2^-/NH_4^+ =2.64). During a period of 120 d the volumetric load was increased up to a value of 56.96 for R1, 38.87 for R2 and 34.52 for R3 (in mmol N-removed/Ld) The activity was measured to compare the evolution of the reactors. The reactors obtained a high efficient removal for NH_4^+ (88.3%, 98.5%, and 98%), nevertheless the reactors could not remove the excess of nitrite (the efficiencies for each reactor are: 97.5%, 68.8%, and 62.5%). Two activity tests demonstrated that the residual nitrite decreased the activity in the anammox process.

PALABRAS CLAVE

- Anammox
- Nitrogen removal
- Membrane bioreactor
- Nitrite toxicity