

## Key role of pH on the performance of continuous anaerobic methane oxidation coupled to denitrification

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**Introduction.** Wastewater treatment plants (WWTP) integrating anaerobic digestion processes are industrial facilities capable of producing gas biofuels from the sludge generated (1). Recent studies have shown that important amounts of CH<sub>4</sub> are released to the atmosphere when anaerobic digesters are purged. Considering that CH<sub>4</sub> has a global warming potential 30 times higher than CO<sub>2</sub> and that each cubic meter of digestate can release ~18 L of CH<sub>4</sub>, it is necessary to develop cost-effective and sustainable technology to control these emissions (2). The anaerobic oxidation of methane coupled to denitrification (N-AOM) is a novel bioprocess capable of oxidizing CH<sub>4</sub> to CO<sub>2</sub> mitigating the greenhouse gas emissions by a factor of 30 (3). This work aimed to systematically evaluate the impact of pH on the performance of a continuous N-AOM reactor through a comprehensive characterization of the CH<sub>4</sub> elimination capacity (EC), nitrite (NO<sub>2</sub><sup>-</sup>) removal rate ( $r_{NO_2^-}$ ), and N<sub>2</sub>O emission potential.

**Methodology.** The experimental system consisted of a cylindrical column coupled to a continuous stirred-tank reactor (CSTR) and a settler. A mineral salt medium enriched with a NO<sub>2</sub><sup>-</sup> concentration of 1306±298 g/m<sup>3</sup> was fed to the column and was deoxygenated by N<sub>2</sub> sparging before entering the CSTR. High-purity CH<sub>4</sub> entered the bottom of the reactor at 17 mL/min. Acclimated biomass from a N-AOM reactor was used as inoculum. Operating conditions for the CSTR included a hydraulic retention time (HRT) of 17 h, 150 rpm, and 30°C. The deoxygenation column was equipped with an optical dissolved oxygen (DO) probe, while pH and DO probes were placed in the reactor. The experimental operation consisted of four phases according to the pH values studied: 7.1±0.4, 6.3±0.3, 8.1±0.1 and 6.3±0.2. EC and  $r_{NO_2^-}$  were assessed by gas and ion chromatography, respectively.

**Results.** N-AOM activity was observed since the start-up of the reactor (Fig. 1). Before 20 days of operation, EC values of ~50 g/m<sup>3</sup>·h were recorded in phase I. Decreasing the pH in phase II led to a significantly higher CH<sub>4</sub> consumption of 63.2±3.3 g/m<sup>3</sup>·h. However, a contrary effect occurred as the pH increased in phase III with an EC as low as 12.9 g/m<sup>3</sup>·h being observed. Decreasing the pH again in phase IV confirmed its

direct impact on the CH<sub>4</sub> oxidation rate. Consequently, EC values of 65.8±7.0 g/m<sup>3</sup>·h were attained in phase IV. These EC values are the highest reported so far for N-AOM reactors. CH<sub>4</sub> removal occurred with a parallel consumption of NO<sub>2</sub><sup>-</sup>. Therefore, pH also had a significant effect on  $r_{NO_2^-}$  as can be seen in Table 1. N<sub>2</sub>O emission potential increased at lower pH values.

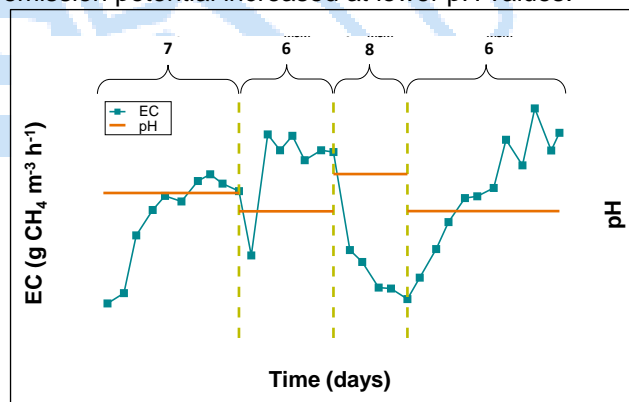


Fig. 1. Performance of N-AOM bioreactor in terms of EC and pH

Table 1. N-AOM performance through the operational phases

Phase	pH	EC (g/m <sup>3</sup> ·h)	$r_{NO_2^-}$ (g/m <sup>3</sup> ·h)
I	7.1±0.4	49.7±3.3	38.1±9.9
II	6.3±0.3	63.2±3.3	48.1±21.7
III	8.1±0.1	20.0±6.8	18.6±10.3
IV	6.4±0.2	65.8±7.0	35.8±3.1

**Conclusions.** The influence of pH on a continuous N-AOM system was assessed in the present work. Small changes in pH (<1) significantly impacted the CH<sub>4</sub> consumption, global NO<sub>2</sub><sup>-</sup> removal rate and N<sub>2</sub>O emission potential. Under the studied conditions, pH 6 was the most favorable to conduct the N-AOM.

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### References

- Kamali M, Gameiro T, Costa ME, Capela I. (2016) *Chem. Eng. J.* 298:162–182.
- Allegue T, Arias A, Fernandez-Gonzalez N, Omil F, Garrido JM. (2018) *Chem. Eng. J.* 347: 721–730.
- Haroon MF, Hu S, Shi Y, Imelfort M, Keller J, Hugenholtz P, Yuan Z, Tyson GW. (2013) *Nature* 500:567–570.