EFFECT OF STRESS CONDITIONS ON THE STABILITY OF AEROBIC GRANULES FOR BIODEGRADATION OF 4-CHLOROPHENOL

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Key words: Aerobic granular sludge, 4-chlorophenol, microbial population dynamics

Introduction. Aerobic granules have excellent settling property, compact microbial structure with diverse microbial species, and ability to withstand shock loadings (1). This technology has been applied to degrade inhibitory compounds including phenols. However, no studies had reported the capacity of these granules to support punctual stress conditions that are common in wastewater treatment plants (WWTP). The objective of this research was to evaluate the long-term operation of an aerobic granular sequencing batch reactor (SBR) degrading 4-chlorophenol (4CP) and, to determine the effect of stress conditions as shock loads and starvation periods on the bioreactor performance and aerobic granule integrity.

Methods. The aerobic granules were formed in an automated SBR with capacity of 6 L (exchange rate of 50%). The reactor was inoculated with microorganisms coming from a municipal WWTP (3 g VSS/L). The reactor was fed with synthetic wastewater containing 200 mg4CP/L as sole carbon and energy source. The changes in microbial community composition were determined applying molecular biology techniques (PCR-DGGE). The granular biomass was exposed to starvation conditions of 24, 48, 72, 96 and 120 hours, and concentration peaks of 200, 400, 600, 800 and 1000 mg 4CP/L. The physicochemical parameters and substrate concentration were determined according to the Standard Methods (2).

Results. The reactor was operated in a long-term stability by 1323 cycles. After the granulation of biomass, the 4CP degradation efficiency was higher than 99%, the sludge volumetric index was reduced from 140 to 38 mL/g and the settling velocity from 0.4 to 11.3 m/h at least 35% of the granules were bigger than 300 µm. DGGE analysis revealed a diverse microbial community in the inoculum (Fig. 1 A) that established in the SBR without major changes in composition (Fig. 1B-H). Dominant bacteria oscillated in their specific abundances throughout the operation of the SBR. Proteobacteria was the most abundant taxa, represented by γ- and β-proteobacteria (57% and 21%, respectively). Genus *Pseudoxanthomonas* was present in all the samples. Shannon diversity index (*H*) varied between 2.48 to 3.09 in the different samples, demonstrating a diverse microbial community compared with activated sludge SBR acclimated to 4CP degradation (*H*=1.7) (3).
The structure of aerobic granules was affected by prolonged starvation periods of ≥ 96 h, decreasing its integrity by 12%, while the degradation activity was also affected, increasing the reaction time 11-fold, but with less impact than in a comparable suspended biomass SBR. The integrity of the granules was lost in a rate of 0.54% integrity per h of starvation (periods longer than 24 h).
Concentration peaks have a significant impact in the specific degradation rate (*q*), degreasing from 67 to 3.5 mg4CP/gVSS/h during a concentration peak of 800 mg4CP/L, which also caused a loss of up to 60% in integrity coefficient (Fig.1B).

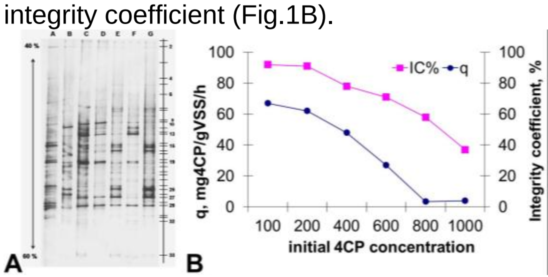

Fig 1 A) DGGE analysis during the long-term operation of the reactor. A: inoculum, B: cycle 24, C: cycle 201, D: cycle 403, E: cycle 578, F: cycle 747 and G: cycle 1320. 1B) Effect of conc. peaks on the specific degradation rate and on the integrity coefficient of the aerobic granules.

Conclusions. The aerobic granular sludge is affected by starvation periods (longer than 96 h) and concentration peaks (higher than 400 mg4CP/L). Granule size decrease as the stress increase (peaks or starvation).

Acknowledgements. Financial support by CONACYT (103720). Technical assistance of Jaime Perez and Gloria Moreno.

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