BIOAUGMENTATION FOR BIOPROCESSES OPTIMIZATION

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Introduction. Bioaugmentation, also known as biomass enhancement is a practice based in the increase of catabolically relevant strains to improve a biochemical process.
Bioaugmentation has proven to be useful for several purposes, including bioremediation, wastewater treatment plants (WWTP), agriculture, aquaculture and biomining.
Despite its use has been reported since more than a hundred years, there is still a controversy in the area of environmental microbiology about its performance and benefits (1). Each application case is unique, and involves a detailed knowledge of involved reactions, substrates and products. Laboratory and pilot scale tests improves the chances of success and its results should be used to scale-up the process.
Successful implementations of a bioaugmentation process involves the consideration of a large number of factors; such as temperature, pH, redox, toxicity, bioavailability, concentration, presence of adequate co-substrates and mass transfer limitations, among others (2). Therefore, to obtain effective results, both biologic and engineering considerations should be considered.
This work present results on pilot and full-scale bioaugmentation systems for WWTP, bioremediation, aquaculture and biomining.

Methods. WWTP parameters: COD, BOD, TSS, NH_3, NO_2, NO_3 and PO_3 were analyzed using standard methods (3). Bioremediation of hydrocarbon contaminated sites was monitored daily for TPH using field kits, and compliance analyses to NOM-138 (4). Shrimp culture ponds respirometry was measured as oxygen consumption rate (OCR) using a polarographic oxygen sensor. Metal content in bioleaching column tests was measured using flame ionization atomic absorption spectrometry.

Results. Bioaugmentation was applied to achieve specific operational goals of the involved process, such as decreasing sludge production, control malodor production, removal of specific contaminants, complying normativity and the increase of capacity or productivity.
Before starting a project, cost-benefit analyses were performed in order to select the best available technology. Results of case histories are summarized in Table 1. Scale is expressed in liter per second (lps) or cubic meters (m3).

Table 1. Case Histories for bioaugmentation systems.

Case History	Scale	Results
Beer industry WWTP	35 lps	Sludge formation reduced by 42%
Municipal sewage	1,800 lps	Malodors controlled in 10 days
Powerplant WWTP	195 lps	Total N removal increased from 6 to 40%
Closed mine water reservoir	35,000 m3	Nitrate reduction from 800 to 15 ppm
Oil refinery WWTP	220 lps	Capacity increase by 25%
Hydrocarbon spills bioremediation	200 m3	Compliance with NOM-138
Shrimp culture ponds	450 Ha	OCR reduced by 60%
Hyperintensive shrimp culture	Raceways 0.5 Ha	total water recirulation
Cyanide removal in silver mine tailings	50 m3	Biodegradation from 40 to <1 ppm
Copper bioleaching	Test columns	Increased recovery by 20%

Strain selection is the most critical step to setup a system. In all cases, an initial dosage and composition was selected, and after 4-6 weeks it was adjusted to the particular process according to the obtained results.

Conclusions. Bioaugmentation is a technology that requires a detailed knowledge of the process and its interactions with the environment. Each case must be engineered for a successful implementation, and supervised for the re-adjustment of dosages.

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