A STUDY AT MICROBIOLOGICAL AND PROCESS LEVEL OF THE INTERACTIONS BETWEEN NITRIFICATION-DENITRIFICATION AND BIOLOGICAL PHOSPHOROUS REMOVAL IN WASTEWATER TREATMENT

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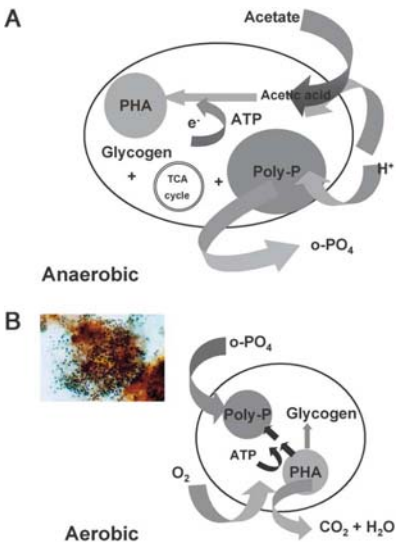

Figure 1. Summary of the major features of the biochemical models for EBPR. The changes that take place during the aerobic (B) and anaerobic (A) stages are shown. The insert shows the microscopic appearance of the biomass under Neisser staining (black cells).

The evolution of legislation and the increase in the knowledge of the basis of the processes involved in wastewater treatment have modified the objectives to be reached in wastewater treatment plants. Actually, an important part of these plants include nitrogen (nitrification and denitrification) and enhanced biological phosphorous removal (EBPR). The combination of these processes results in the coexistence of diverse microorganisms whose optimal operational conditions are very different, and it is thus necessary to reach an equilibrium state. Moreover, biological phosphorous removal is a non stationary process and is heavily influenced by nitrification and denitrification processes. In this context, biological phosphorus removal has become one of the most important processes, but little is known about the microbial groups participating in the reactions. Therefore, not only the study of the influence of operational parameters is crucial to achieve successful phosphate and nitrogen removal in wastewater treatment plants, but also the study of microbial communities involved in these processes.

The A2O process is one of the basic configurations used for biological nitrogen removal along with biological phosphorus removal. This system consists of an anaerobic zone followed by an anoxic and an aerobic zone. Under anaerobic conditions, the polyphosphate accumulating organisms (PAO) rapidly assimilate organic substrates like acetate synthesizing poly-hydroxi-alkanoates (PHA) using stored polyP as an energy source. Hence, the orthophosphate generated from polyP degradation is released into the bulk liquid (Fig. 1). In the absence of any organic compounds in the aerobic zone, the microorganisms with stored PHA are able to use them as carbon and energy sources to grow and to assimilate phosphate synthesizing polyphosphate (Fig. 1). At the same time, nitrification occurs in the aerobic stage. Nitrification is the microbiological process by which ammonia is oxidized first to nitrite by ammonia-oxidizing bacteria (AOB) and then nitrite to nitrate by nitrite-oxidizing bacteria (NOB). AOB and NOB are collectively known as nitrifying bacteria or nitrifiers. The nitrate produced in the aerobic stage is then recirculated to the anoxic zone where denitrifying organisms oxidize it to nitrogen gas.

This project aims at studying and optimizing the main variables that influence EBPR, with special emphasis in the influence of the nitrification-denitrification processes on biological phosphorous removal. The study will be carried out in a continuous pilot plant in which the influence of operational conditions on process yield and stability will be analysed at both macroscopic and microscopic levels. Batch tests in bioreactors will be also conducted in order to assess the influence of phosphorous removal on heavy metal removal. Different biological techniques, such as microorganisms count, FISH and DGGE will be employed for the characterization of the biomass in the bioreactors mentioned above and the existence and expression of specific genes of importance for the processes will be studied.

Figure 2. A2O Pilot plant

Relevant publications

Rodríguez Rodríguez E, Martín Sanpedro R, García Encina P, Rojas A (2007) *Fluorescent in situ hybridization as a control parameter on an activated sludge system.* International Conference on Technologies for Industrial Wastewater Treatment and Reuse in the Mediterranean Region (TIWATMED), May 24-26, 2007, Jerba, Tunisia.

Rodríguez Rodríguez E, Ferrero Infestas E, García Encina P *Analysis of bacterial community in two wastewater treatment plants by denaturing gradient gel electrophoresis (DGGE) and fluorescent in situ hybridization*. The Third International Meeting on Environmental Biotechnology and Engineering (3IMEBE), September 21-25, 2008, Palma de Mallorca, Spain.