

Title: Vertical Profiles of Temperature and Ammonia and Tracer Study on Subsurface flow Wetlands

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## ABSTRACT

Wetlands are ecosystems that exist in the nature in a natural form and they are considered to be one of the most efficient natural systems in purifying water. The high efficiency of wetlands for mineralizing the organic matter of water is due to a high presence and growth of micro-organisms, thanks to a combination of several elements such as water, gravel, light, nutrients and vegetation.

Constructed wetlands try to reproduce from its design the characteristics of natural wetlands, not just from a point of view of purifying wastewater but for improving habitats. Inside the group of constructed wetlands that are used for treating wastewater, subsurface flow constructed wetlands is characterized by the water flows through gravel porous soil, below the surface of soil and in contact with roots of plants. These natural systems have been developed during the last 20 years in Europe and this recent introduction has reconsidered its design criteria, in order to be able to increase its efficiency and reduce the needs for space. Along these research lines, the Section of Sanitary and Environmental Engineering at “Universitat Politècnica de Catalunya” (UPC) and the “Centre Superior d'Investigacions Científiques” (CSIC) are developing together a research project in a pilot plant formed by eight subsurface flow constructed wetlands, with four different kinds of length-to-width ratios and two different kinds of granular medium. This work is placed inside this research.

This study analyzes the daily variations in temperature and quality of the water that flows through the granular medium of two subsurface flow constructed wetlands, with similar dimensions but with beds of different granular medium size, called C1 (coarse gravel) and C2 (smaller gravel). It has been measured particularly the distribution of temperature of water according to the depth throughout several days of August, when the environment temperature is supposed to be the highest in the year. With this information, we can register the existence of thermal stratification of water inside the wetlands. In the second place, we characterize the quality of water flowing through the granular medium, at a specific time, in terms of ammonia concentration.

The thermal profile is practically invariable during daytime for a given water column and along the wetlands, without finding a strong thermal stratification of flowing water. This is attributed to the vegetable cover, which is well developed on the surface of the beds during the campaign. In relation to the concentration of ammonia, we have noticed a light increase with the depth of water inside all perforated tubes inserted in beds of the constructed wetlands under consideration. These profiles are also similar to each other, without noticing differences along length of wetlands nor between beds of different granular medium size.

The vegetal cover on the surface of the wetland influences the distribution of temperature of water. Two representative samples from each of the two considered wetlands allow to see differences between the two kinds of soils. Wetland C2 presents a higher amount of aerial part and roots of plants than wetland C1.

The efficiency of constructed wetlands depends on the time the wastewater spends in the bed, among other factors. A tracer study using bromide allows to determine the mean time that tracer particles take to go through wetlands C1 and C2, taking samples from three different depths of intermediate points and from the effluent. We have not observed preferential water flow on the first half of the two wetlands, but we have detected a lower average tracer retention time at the bottom of the beds of the water column situated on a horizontal distance of 2,6 m from the final edge of the wetlands. This fact may be attributed to the position of the outlet, whose tube is installed at the bottom of the final edge of the wetlands.

In short we have not registered a thermal stratification of water inside the wetlands during the campaigns; this may be attributed to the density of reeds and the existence of a layer of organic dead matter over the beds. The concentration of ammonia increases with the depth of water because the dissolved oxygen decreases with the depth, what explains the lowest level of the nitrification process. Wetland C2 presents a higher amount of reeds than wetland C1; these differences are due probably to the different porosity of the beds. A tracer study allows to see preferential water flow at the bottom of the beds near the final edge of the wetlands; this may be attributed to the position of the outlet at the bottom.