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Constructed wetlands to help recovery of effluent dominated streams: application to ozonated and non ozonated treated effluents

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Constructed wetlands to help recovery of effluent dominated streams: application to ozonated and non ozonated treated effluents

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Abstract: The paper reports the results of comparative trials carried out at demonstrative and pilot scale using constructed wetlands for the final polishing of treated effluents (ozonated and non ozonated) which are discharged into a small stream, often dry, whose flow is chiefly made of the effluents themselves. The effluents fed to experimental constructed wetlands had comparable quality for the chief parameters. The removal percent was higher in the case of ozonated effluents for total phosphorus and total nitrogen, especially due to the higher concentration of oxygen, while COD and TSS reval were comparable in the two cases.

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Introduction

The problem of low environmental quality of rivers is often related not only to polluting loads in themselves, but also to other kinds of anthropogenic pressures. In Italy, a very important one is the low and variable flow characterizing most of the watercourses, due to the intensive exploitation of water resources and also related to the climate change. Considering the river as a complex ecosystem, where morphological, hydrological an biological aspects contribute to the overall environmental quality, it is easy to understand the negative effects of poor and variable flows.

On the other hand, wastewaters coming from wide areas are normally collected in combined sewage networks and fed to large size, centralized wastewater plants, in order to optimize their treatment. As a consequence, high flows, resulting from both treated effluents and, when it rains, rainwater and run-off water, are discharged in a single site. Even if the plant performance is good, the residual presence of low concentration of pollutants may generate high polluting loads. In the end, as the available dilution in the receptor is often low, the effect of the input of any polluting load results in a fast increase of polluting concentration. As the difference between the standards in force for discharge and for river water quality is often great, in many cases a polishing treatment is needed in order to restore an acceptable environmental quality, especially in the cases known as “effluent dominated streams” (Schmidt, 1993).

When land availability is enough, constructed wetlands (CW) are interesting options for polishing, as their operation costs are low and their presence involves a positive environmental impact contributing to the overall biodiversity of the area, at the same way as natural wetlands.

Land availability is definitely a crucial point and can affect dramatically the investment costs, as the suggested hydraulic retention time is normally of some days and the specific surface requirement for polishing is around 1 m^2 per EI (EPA, 2000; WPCF, 1990). A further point which can make the difference in economic is the need for sealing the bottom of the CWs, according to the permeability of soil, to the hydrogeological characteristics of the area and, of course, to the regulations in force.

The present paper deals with the results of a research at demonstration and pilot scale carried out in a site representative of the above mentioned situation: the flow of the receptor is practically only made of the flow of three wastewater treatment plants and practically no dilution of the discharged effluents can occur (Canobbio and Mezzanotte, 2003; Mezzanotte et al., 2005).

Material and Methods

Experimental activities were carried out at demonstration scale (2 sectors, 16 x 2,5 m^2 each, filled with different size gravel) and at pilot scale (3 reactors, 2 x 0.5 m^2 each, one of them used as blank, without any crop) (Figure 1.1).

Figure 1.1 – Pictures of the demonstration (left) and of the pilot (right) plants and scheme of a horizontal subsurface flow system)

After two years of parallel working, during which the demonstration and the pilot plants (both horizontal subsurface flow systems, HSSF) had been fed on the same effluent and had demonstrated to give comparable performances (Mezzanotte et al., 2010), the pilot plants were moved to Alto Lura wastewater treatment site, where it was fed on the ozonated effluent (about 10 mg O_3/L), while the demonstration one was kept at Livescia wastewater treatment site and fed on a biologically treated effluent. Both treatment plants are located in Northern Italy (Como province) and receive mixed sewage, including an important contribution from textile dyeing industry and from the runoff of urban areas. Their effluents have a remarkable component of residual dyestuffs, surfactants and their metabolites. The COD/BOD_5 ratio was 5,57 and 5,15 for Livescia and Alto Lura WWTP, respectively. Alto Lura WWTP includes a final ozonation step, while Livescia WWTP does not. After comparing the performances of the two experimental plants, a comparison was made between the two situations in order to evaluate if the efficiency of constructed wetland improved after ozonation.

The pilot and demonstration plants worked continuously (pilot plants were placed inside and artificially lighted). The demonstration and the pilot plants (2 days HRT) were cropped with *Phragmites australis* and *Typha latifolia*.

Average 24-h samples were collected weekly at the inlet and at the outlet of the experimental plants. The effluents were collected 2 days after the inlet one, to account for the hydraulic retention time. The analyses concerned the main reference parameters (pH, electric conductivity, COD, Total N, N-NO3, N-NO2, N-NH4, Total P, Total Suspended Solids) and were carried out according to Standard Methods (APHA, 1998).

Results and Discussion

Figure 2.1 compares the values of the main control parameters at the inlet and at the outlet of the experimental plants (only for the two cropped reactors in the case of the pilot plant).
At the inlet, the analyzed parameters have comparable values, except for SST and COD which were lower in the case of the demonstration plant. At the outlet, the concentrations were lower for the pilot plants, due not only to the lower starting values, but also to the greater removal efficiency, as shown in Figure 2.2.

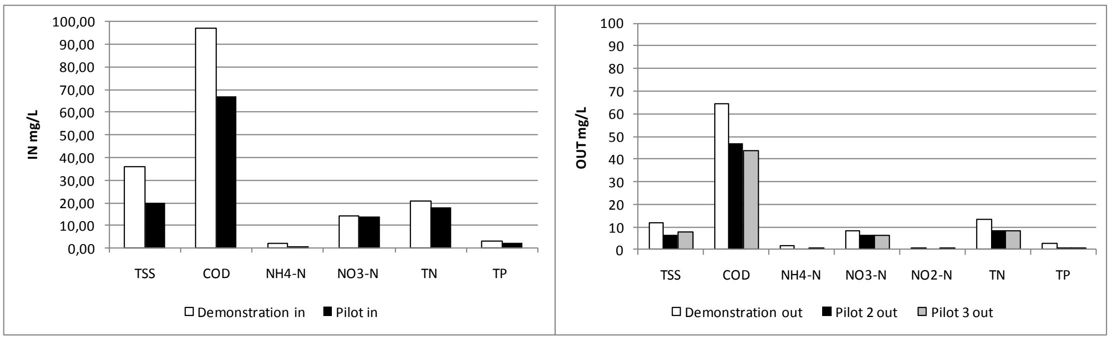

Figure 2.1 Mean values of Total Suspended Solids, COD, NH_4-N, NO_3-N, Total nitrogen and total phosphorus at the inlet and at the outlet of the experimental plants.

The difference is particularly clear for total nitrogen and total phosphorus and can be attributed to the higher redox potential of the ozonated effluent. In fact, in oxidizing conditions phosphorus precipitates and is thus retained by the filling material of the wetland and the oxidation of ammonia nitrogen is more efficient. The overall removal of total nitrogen is thus enhanced by the fact that plants uptake it as nitrate rather than as ammonia. As expected, no difference was observed for the removal of total suspended solids. On the contrary, we expected a greater removal of COD from the ozonated effluent which, however, did not occur.

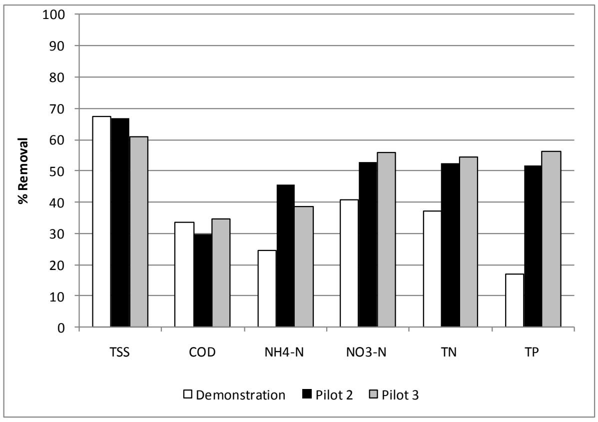

Figure 2.2 Comparison between percent removals in the demonstration and pilot plants

The obtained percent removal were satisfying, but the obtained values are still far from the level required for classifying the receptor as belonging to a good quality class, according to the Italian standards.

Further tests will be carried out to assess in the influence of the ozone dose on the degradability of residual COD and on the removal of specific compounds such as non ionic surfactants by the biomass active in the constructed wetland.

References

APHA, AWWA, WEF (1998), Standard Methods for the Examination of Water and Wastewater, 20th ed.

EPA (2000), Guiding Principles for Constructed Treatment Wetlands: Providing for Water Quality and Wildlife Habitat, EPA 843-B-00-003

Schmidt, K. D. (1993), Proceedings of the symposium on Effluent Use Management. American Water Resources Association Technical Publication Series, TPS-93-3.

Liu, C., Du, G., Huang, B., Meng, Q., Li, H., Wang, Z., Song. F. (2007), Biodiversity and water quality variations in constructed wetland of Yongding River system. Acta Ecologica Sinica, 27(9), 3670–3677.

Canobbio, S., & Mezzanotte, V. (2003), Studio sulle caratteristiche ecologiche del torrente Lura. 13th National Congress of the Italian Ecology Association, Como.

Mezzanotte, V., Canobbio, S., & Barletta, D. (2005), Studio sulla Qualità Ambientale del Torrente Lura. L'Acqua, 4(5), 17–23

WPCF (1990), Natural systems for Wastewater Treatment. Water Pollution Control Federation, Manual of Practice FD-16, Alexandria, VA, USA.

Mezzanotte, V., Buttiglieri, G., Canobbio, S., Occhiuto, F., Teli, A., Malpei, F., Benvenuto, F.(2010), Case study – Constructed wetland for polishing mixed wastewaters discharged into an effluent dominated stream. 12th International Conference on Wetland Systems for Water Pollution Control, Venice (Italy), September 2010