Microalgae as a Sustainable and Cost-Effective Alternative to the Traditional Nutrients Removal in Small WWTP

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Among the functional elements of a wastewater reuse system, storage has an important role in preventing discharge of treated wastewaters to water bodies while allowing the continuously produced volumes to be utilised during the narrowest period of the irrigation season. Several researches have however established that, under proper operations and conditions, storage inside a Wastewater reservoir (WWR) can lead to a significant improvement of the water quality for irrigation as a consequence of a complex system of physical-chemical and biological processes that are typical of hypertrophic water bodies with slow water turnover. However the input of fresh wastewaters in the reservoir, and related nutrients load can cause drastic changes in planktonic community, the consequent sensible increase in VSS, chlorophyll and the increase in sprinkler clogging risks when drip irrigation is used.

Controlling the entrance of nutrients within the reservoir is mandatory but most of the small to medium wastewater treatment plant, especially in Southern areas of Italy, suffer from the lack of a denitrification phase and its inclusion within the treatments line is often hindered by lack of space or hydraulic profile constrains. The nutrient levels could be however economically controlled by properly exploiting the removal efficiency of high rate algal ponds (HRAPs) of tubular photobioreactor (PBR), followed by the algae separation through filtration/centrifugation. Wastewater will provide a conducive growth medium for microalgae because the CO_2 balances the Redfield ratio (molecular ratio of carbon, nitrogen and phosphorus) of the wastewater allowing for faster production rates, reduced nutrient levels in the treated wastewater, decreased harvesting costs and increased lipid production. Microalgae, by removing nitrogen and carbon from water can significantly reduce the eutrophication in the Wastewater reservoir aquatic environment and constitute a base for bio-fuel or bio-fertilizer production.

The literature for microalgae production is quite extensive; however, only few robust feasibility studies are available. Additionally the production and costs data are quite dispersed. A procedure to evaluate the cost of using HARP and PBR for the removal of nutrients in wastewater from small to medium size plants is here proposed allowing the comparison of data from case studies that differ in several basic assumptions depending on the country and year of manufacture, the typology of the plant, its volume and surface, the plant scale, the biomass productivity.

Results are provided in terms of HARP and PBR net production cost as a function of plant surface (m^2) and specific productivity. A comparison of unit costs per cubic meter of treated wastewater is provided for traditional denitrification and nutrient removal via HARP and PBR. A feasibility analysis is finally performed as a function of the wastewater reuse system capacity.