

Natural Treatment Systems for Reclaimed Water Use and Bioresource Recovery: A Palestinian Experience

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Abstract

Phytotechnologies, waste stabilization ponds (WSPs) and constructed wetlands (CWs), play a key role in stabilization of organic and inorganic matter in domestic, municipal and industrial wastewater during secondary and tertiary treatment. Utilizing solar energy and carbon dioxide, WSPs microalgae produce oxygen for autotrophic and heterotrophic bacteria to degrade organic and inorganic pollutants, respectively. Aeration through algal oxygenic photosynthesis reduces annual energy costs compared with mechanical aeration applied in mechanised systems for wastewater treatment. This paper reviews the Palestinian experience in the application of pilot and large-scale algae-based systems for domestic wastewater treatment and reuse. During the years 1997-2002, pilot-plant investigations have been conducted at Birzeit University campus, where oxygenic photosynthesis in algae-based ponds was applied for wastewater treatment. Major basic principles obtained from these pilot studies can be used for the engineering design of biological nutrient processes or performance enhancement of new or existing overloaded oxidation ponds. The chemical, biological, operational, and economic factors that affect the use of engineered algae-based ponds and innovative photobioreactors with algal-bacterial biomass as feasible methods for producing oxygen and biologically safe reclaimed water are presented and discussed. Recent studies reported that algal-based ponds are quite sensitive towards a wide range of industrial discharges entailing hazardous organic and inorganic chemicals. Therefore, innovative design and practical operational procedures are necessary to sustain microbial biomass within the oxidation ponds. Ongoing research studies focus on the application of natural treatment systems (microalgae-based and algal-bacterial processes and constructed wetlands) for the reclamation of anaerobically treated agrifood industrial effluents (olive oil mills, dairy and slaughterhouse facilities). Guidelines for system design, start-up, and operation of pilot algal-bacterial systems and constructed wetlands shall be identified and discussed, where areas for further research are identified. Proper algal system configuration, cultivation and harvesting are crucial engineering design criteria of phytotechnologies pertaining to process sustainability, reclaimed water safety, land cost, and algal biomass use.

Keywords: Constructed wetlands, industrial wastewater, microalgae, photobioreactor, wastewater treatment, water reclamation