Performance assessment of up-flow anaerobic multi-staged reactor followed by auto-aerated immobilized biomass unit for treating polyester wastewater, with biogas production	
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Abstract: Polyester manufacturing industries produce highly polluted effluents, containing organics, nutrients, trace metals, and 1,4-dioxane, requiring a high degree of treatment before being discharged into the water bodies. This study focused on removing complex pollutants from a diluted polyester industrial effluent (DPIE) via a cost-efficient anaerobic/aerobic combined system, with biogas recovery. The integrated pilot-scale system was composed of an up-flow anaerobic multi-staged reactor (UASR; V = 41 L) followed by an auto-aerated immobilized biomass (AIB; V_{sponge} = 9.54 L) unit and operated at a total organic loading rate (OLR) of 0.75 ± 0.16 g COD/L/d and pH of 7.14 ± 0.14 at 25 °C. The UASR achieved removal efficiencies of 17.82 ± 3.14% and 15.90 ± 3.08% for chemical oxygen demand (COD, total and soluble) and 15.83 ± 4.68% for total Kjeldahl nitrogen (TKN), with bio-CH_4 yield of 263.24 ± 31.98 mL/g COD. Adding the AIB unit improved the overall COD_{total}, $COD_{soluble}$, and TKN to 93.94 ± 2.39%, 94.84 ± 2.23%, and 75.81 ± 3.66%, respectively. The NH_4-N removal efficiency was 85.66 ± 2.90% due to the oxic/nitrification condition on the sponge's outer surface. The entire system also achieved 73.26 ± 2.68%, 77.48 ± 5.74%, and 81.26 ± 6.17% removals for Fe (3.93 ± 0.95 ppm), Zn (5.92 ± 2.32 ppm), and 1,4 dioxane (2.50 ± 0.61 ppm). Moreover, the UASR-AIB maintained removal efficiencies of 76.53 ± 8.47% and 77.51 ± 7.38% for total suspended solids (TSS: 335.95 ± 42.84 mg/L) and volatile suspended solids (VSS: 263.50 ± 36.94 mg/L). Regarding the DPIE toxicity level, the EC_{50} value increased from 12.9 to 39.4% after UASR/AIB application. The UASR's microbial community at the genus level demonstrated that the synergistic cooperation of solubilization, hydrolysis, acidogenesis, acetogenesis, and methanogenesis was responsible for the degradation of DPIE components.