NITROGEN REMOVAL EFFICIENCIES AND PATHWAYS FROM ANAEROBIC AND ANOXIC ZONES IN A LABORATORY-SCALE VERTICAL FLOW CONSTRUCTED WETLAND

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Abstract - A laboratory-scale vertical flow constructed wetland system was designed to investigate nitrogen removal rates and pathways from both anaerobic and anoxic zones. Each wetland replicate comprised a gravel filter bed with a water table maintained at 27 cm above the base of the gravel packed into 40 cm columns, thus providing both anaerobic and anoxic zones, which were sampled independently throughout the experiment. The wetland was seeded with activated sludge and supplied with synthetic wastewater containing 508 mg/L N. After establishing the initial constant concentration conditions in each replicate wetland the flow was shut off and monitoring performed under no-flow conditions. The study also sought to investigate whether the anaerobic ammonium oxidation process (anammox) could operate without seeding anammox bacteria under high nitrate loading rates and ambient temperatures. Weekly measurements of nitrate, nitrite, and ammonium concentrations, chemical oxygen demand, temperature, oxidation-reduction potential, and hydrogen ion concentration were taken throughout the study. At the end of the experiments, PCR analysis of 16S rRNA gene sequencing was performed to identify the microbial communities in the anoxic and anaerobic parts of the system. The nitrogen compounds were removed from the system after 182 days, with similar total nitrogen removal efficiencies (94% and 93%) for anoxic and anaerobic layers respectively. Anammox bacteria were not present and heterotrophic bacteria were the dominant bacterial strains involved in nitrogen transformation and accounted for 80% of the total bacteria in the anoxic zone and 60% in the anaerobic zone. With little difference in the removal efficiencies of the anoxic and anaerobic zones, a more effective design would be an entirely saturated wetland as the total mass removal of nitrogen depends on the volume stored, which at full saturation was seven times greater per unit wetland volume than the unsaturated zone.

Keywords - Vertical Flow Constructed Wetland, Nitrogen removal, Anoxic zone, Anaerobic zone, Bacterial composition