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Maintaining low concentrations of nitrogen compounds in aquaculture water is a key requirement for a recirculating aquaculture system (RAS), due to the potential detrimental effects of ammonia or nitrate on fish growth and metabolic activities. Herein, a microbial fuel cell (MFC) was investigated to accomplish the removal of either nitrate or ammonia from real RAS water (with simulated daily nitrate/ammonium accumulation) while generating electricity, via aerobic nitrification in the cathode, electricity/concentration driven transport across anion exchange membrane, and subsequent heterotrophic denitrification in the anode chamber. The experiment went through two stages, nitrate removal (Stage I) and ammonia removal (Stage II). In Stage I when daily nitrate addition was performed to mimic nitrate accumulation (0.050 kg NO₃⁻-N m⁻³ NCC d⁻¹, NCC: net cathodic chamber volume) in the MFC cathode, a stable current density of 12.48 A m⁻³ could be achieved with a 73.3% nitrate removal and 91.3% COD removal at the end of day 15. To better mimic ammonium accumulation in the RAS effluent without a biofilter, daily ammonium addition (0.050 kg NH₄⁺-N m⁻³ NCC d⁻¹) was performed in the cathode in Stage II. The MFC system achieved a total inorganic nitrogen removal rate of 0.051 kg N m⁻³ NCC d⁻¹, and a COD removal efficiency of 91.8% with a current density of 74.00 A m⁻³. A preliminary analysis of energy balance indicated that the proposed MFC could potentially achieve energy-positive RAS water treatment with a net energy production of 7.50 × 10⁻³ kWh m⁻³ treated RAS water or 0.145 ± 0.031 kWh kg⁻¹ removed nitrogen. The results of this study indicate that MFCs have a potential to treat RAS water with simultaneous energy recovery.

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