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Electrifying Textile Wastewater Sludge through Up-flow Anaerobic Sludge Blanket Reactor for Sustainable Waste Management

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Abstract : Energy supply and waste management are two of humanity's greatest challenges. The world's energy supply primarily relies on fossil fuels, which produce excessive carbon dioxide emissions when burned. When released into the atmosphere in high concentrations, these emissions contribute to global warming. Generating textile wastewater sludge from the Bahir Dar Textile Industry poses significant environmental challenges. This sludge, a byproduct of extensive dyeing and finishing processes, contains a variety of harmful chemicals and heavy metals that can contaminate soil and water resources. This research work explores sustainable waste management strategies, focusing on biogas production from textile wastewater sludge using up-flow anaerobic sludge blanket reactor technology. The objective was to harness biogas, primarily methane, as a renewable energy source while mitigating the environmental impact of textile wastewater disposal. Employing a Central Composite Design approach, experiments were meticulously designed to optimize process parameters. Two key factors, Carbon-to-Nitrogen ratio, and pH, were varied at different levels (20:1 and 25:1 for C: N ratio; 6.8 and 7.6 for pH) to evaluate their influence on methane yield. A 0.4m3 up-flow anaerobic sludge blanket reactor was constructed to facilitate the anaerobic digestion process. Over 26 days, the reactor underwent rigorous testing and monitoring to ascertain its efficiency in biogas production. Meticulous experimentation and data analysis found that the optimal conditions for maximizing methane yield were achieved. Notably, a methane yield of 56.4% was attained, which signifies the effectiveness of the up-flow anaerobic sludge blanket reactor in converting textile wastewater sludge into a valuable energy resource. The findings of this study hold significant implications for both environmental conservation and energy sustainability. Furthermore, the utilization of up-flow anaerobic sludge blanket reactor technology underscores its potential as a viable solution for biogas production from textile wastewater sludge, further promoting the transition towards a circular economy paradigm.

Keywords : anaerobic digestion, biogas energy, circular economy, textile sludge, waste-to-energy
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