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Statistics Driven Comparative Study of Performance Between Conventional and Waste Derived Microbial Fuel Cell

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Abstract

A theoretical comparative study framework is proposed to statistically evaluate the performance and cost metrics of microbial fuel cells (MFCs) built from conventional materials versus those utilizing waste-derived components. The study aims to synthesize and normalize quantitative performance indicators such as power density, chemical oxygen demand (COD) removal efficiency, Coulombic efficiency, and operational lifespan for both conventional (e.g., high-purity electrodes, commercial membranes, synthetic substrates) and waste-based (e.g., recycled electrodes, membranes from waste polymers, organic waste substrates) MFC designs. Cost parameters are systematically estimated from available literature and theoretical market data, accounting for raw material, fabrication, and maintenance considerations. Employing descriptive statistics, hypothesis testing, effect size calculations, and regression modelling, the study identifies statistically significant differences, trade-offs, and success factors under varying operational conditions. This rigorous methodology provides critical, evidence-based insights into the feasibility, environmental benefit, and application potential of waste-derived MFC technologies, ultimately guiding research directions and sustainable engineering decisions.

Keywords: Microbial fuel cell; Waste derived MFC; Conventional MFC; COD removal efficiency; Coulombic efficiency; Power density.