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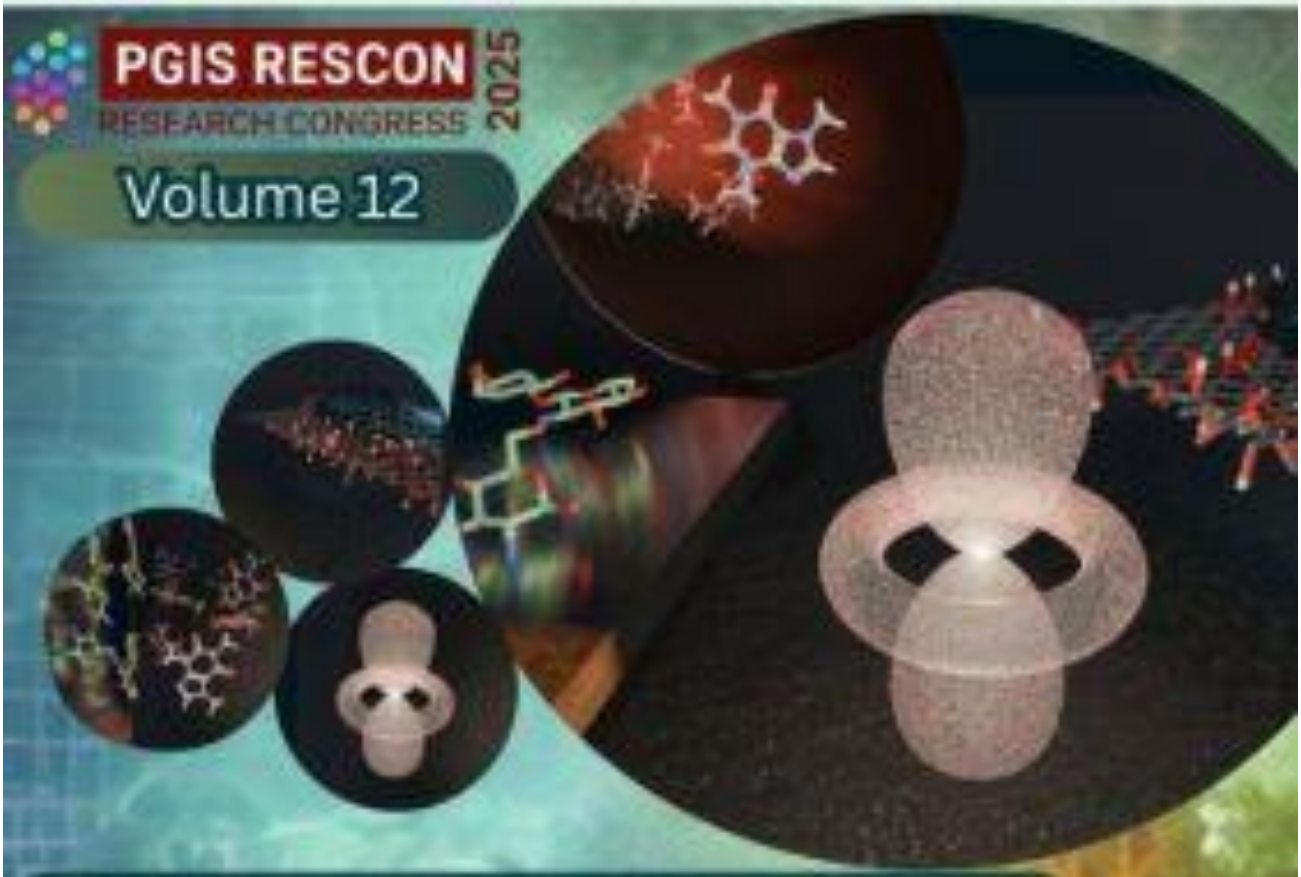

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OPTIMISING Na_2SO_4 ELECTROLYTE CONCENTRATION FOR SUPERCAPACITORS FABRICATED WITH ACTIVATED CARBON DERIVED FROM WASTEWATER FILTERS

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The current demand for energy storage technologies has provoked significant interest in supercapacitors, mainly due to their rapid charge-discharge capabilities, long cycle life, and high-power density compared to commercially available batteries and fuel cells. In electric double-layer capacitors, the electrode material and the electrolyte directly affect the performance of the device. Biomass-derived activated carbon materials have been extensively studied due to their low-cost, high surface area, and favorable electrochemical properties. However, the suitability of activated carbon obtained from wastewater filter residues remains underexplored. This study investigated the electrochemical performance of supercapacitors fabricated using activated filter carbon (AFC) derived from wastewater filters, with a focus on optimising the concentration of aqueous Na_2SO_4 electrolyte. The waste filters were cleaned and then thermally treated at 900 °C for 20 min in a low oxygen environment and activated via water quenching. The resulting carbon was then processed into electrodes and assembled into symmetric supercapacitor cells. Thereafter, electrochemical characterisation was conducted using cyclic voltammetry and galvanostatic charge-discharge techniques using various concentrations of Na_2SO_4 (1.5 – 3.5 mol L^{-1}) as the electrolyte. The results show that the optimum electrolyte concentration was 2.0 mol L^{-1} of Na_2SO_4, yielding the highest specific capacitance of 17.06 F g^{-1}, with an energy density of 12.45 W h kg^{-1} and a power density of 800.21 W kg^{-1}. A decrease in specific capacitance at higher concentrations is attributed to increased electrolyte viscosity, which reduces ion transport, as observed in previous studies. This work highlights the suitability of using waste derived AFC for sustainable energy storage and shows the importance of electrolyte optimisation in supercapacitor design.

Keywords: Activated carbon, Electrolyte concentration optimisation, Supercapacitors, Wastewater filter recycling