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Comparative Study of Activation Energy and Desulfurization Efficiency of Coal in Graphite and Dimensionally Stable Anode (DSA) Electrodes

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Abstract

This study investigates the electrochemical desulfurization of sulfur-rich subbituminous coal (6.96 wt.%) from the Bogovina Basin using graphite and dimensionally stable anode (DSA) electrodes. The objective was to evaluate and compare the efficacy of these electrodes under varying thermal conditions to determine the optimal operational parameters that balance desulfurization efficiency with energy consumption. Electrochemical assessments were conducted through linear sweep voltammetry (LSV) to derive polarization curves and calculate activation energies, reflecting the intrinsic energy barriers of the desulfurization reactions. These tests were performed across a temperature range from 30°C to 70°C, providing insight into the thermally activated nature of these processes. The results demonstrated that the DSA electrodes outperformed the graphite electrodes in several key areas. Notably, DSA electrodes exhibited higher current densities at equivalent temperatures and potentials, indicating a more robust electrochemical activity conducive to higher desulfurization rates. Moreover, activation energy analysis revealed that DSA electrodes operate with significantly lower energy barriers, facilitating easier and more efficient reaction initiations. Energy consumption metrics were critical in evaluating the operational costs associated with each electrode type. The DSA electrodes were found to consume less energy per kilogram of sulfur removed, particularly at an optimal temperature of 50°C, which was identified as the most energy-efficient operational point. At this temperature, the DSA electrodes achieved peak desulfurization efficiency with the most favorable balance between energy input and desulfurization output. The study substantiates the superiority of DSA electrodes over traditional graphite electrodes for coal desulfurization processes, particularly at the optimal operational temperature of 50°C. The findings highlight significant potential for enhancing the sustainability and cost-effectiveness of coal desulfurization technologies, suggesting a paradigm shift towards the adoption of DSA electrodes in industrial applications to achieve more efficient and environmentally friendly outcomes.

Keywords: *electrochemical desulfurization; subbituminous coal; dimensionally stable anode (DSA); graphite electrodes; optimal temperature; energy efficiency*