

Valorization of Corncob Waste into Cellulose Adsorbents: A Techno-Economic Perspective

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Abstract—Corncobs, one of the leading agricultural wastes in South Africa, have posed significant environmental challenges. However, converting them into valuable products offers a sustainable solution to mitigate these impacts. The outstanding properties and wide applications of cellulose adsorbents have necessitated the development of sustainable and affordable production procedures. The techno-economic analysis of the process is essential to evaluate the technological and economic viability of cellulose adsorbents synthesis from lignocellulosic waste biomass. Therefore, this study evaluated the techno-economic analysis of isolating cellulose adsorbents from corncobs using liquid hot water pretreatment and alkali treatment. Based on the experimental dataset, the industrial-scale process was simulated in a batch mode, under isolation conditions of 150 °C, 60 minutes, and 10% w/w solid loading using Aspen HYSYS software. The corncob powder feed rate was scaled up to 3000 kg/h to produce cellulose adsorbents. The techno-economic analysis of the scaled-up plant was evaluated using the Process Economic Analyzer of Aspen HYSYS software. The simulated process plant produced 11,334 metric tons of cellulose adsorbents annually by transforming 41,610 metric tons of corncob waste. The techno-economic parameters, which include the total project capital cost, the annual operating cost, and the annual total product sales of the process plant, were estimated to be \$22.32 million, \$36.39 million, and \$51.01 million, respectively. Furthermore, at a minimum selling price of \$4.50/kg for the cellulose adsorbents, the process plant demonstrated a net present value of \$35.46 million, an internal rate of return of 39.54%, a net return rate of 13.51%, a payback period of 5.48 years, and a profitability index of 1.135. Therefore, the environmentally friendly method of producing cellulose adsorbents from corncobs and its techno-economic evaluation confirmed the industrial upscaling of the process for financial benefits.

Keywords— Biomass Valorization; Cellulose Adsorbents; Corncobs; Techno-Economic Analysis.

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