

DESIGN, ENVIRONMENTAL AND TECHNO-ECONOMIC ASSESSMENT OF A BIOREFINERY FACILITY DEVELOPED FOR THE CONVERSION OF THE OFMSW INTO POLYURETHANES

S. Skoutida¹, S. M. Ioannidou¹, D. Ladakis¹, A. Koutinas^{1*}

¹Department of Food Science and Human Nutrition, Agricultural University of Athens, Iera Odos 75, 118 55 Athens, Greece

(*akoutinas@aua.gr)

ABSTRACT

The Organic Fraction of Municipal Solid Waste (OFMSW) constitutes a ubiquitous waste stream that is generated in abundant quantities amounting to 30-40% of the total Municipal Solid Waste^[1]. The OFMSW is rich in starch and lignocellulosic components, therefore it constitutes an optimal resource for processing through fermentation to attain the formulation of bio-based chemicals, polymers and fuels^[2,3]. In this study, the simulation of an OFMSW-based biorefinery is addressed including i) the conversion of the OFMSW into a sugar-rich hydrolysate, ii) the fermentative production of succinic acid as intermediate product using the bacteria *Escherichia coli* and iii) the subsequent transformation of the monomer into polyurethane dispersions. The potential of this conceptualized biorefinery is evaluated by conducting the process design of the plant, complemented with a techno-economic evaluation and a Life Cycle Assessment (LCA). The performance of process design encompasses the estimation of the mass and energy balances, sizing of unit operations and optimization of the plant's operating capacity. Techno-economic evaluation and Discounted Cash Flow analysis were performed to estimate important techno-economic indicators, namely Fixed Capital Investment (FCI), Cost of Manufacture (COM), Net Present Value (NPV) and Minimum Selling Price (MSP). The NPV is calculated at M\$1,030 highlighting the profitability of the plant while the MSP of the polyurethanes is estimated at \$2.63/kg for an annual production capacity of 193,700 t. A cost category that contributes significantly to the overall expenses is the cost of raw materials (M\$355.8). Additionally, the environmental assessment indicates the improved environmental performance of the proposed biorefinery as compared to the conventional production of polyurethanes, leading to 20-25% of greenhouse gas emission savings. Furthermore, the OFMSW valorization scenario is compared to the conventional management routes of the OFMSW, demonstrating the environmental benefits of the proposed biorefinery.

KEYWORDS: Biorefinery, Organic fraction of Municipal Solid Waste, Polyurethanes, Techno-economic evaluation, Life Cycle Assessment

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