A Prospective Life Cycle Assessment (LCA) of Monomer Synthesis: Comparison of Biocatalytic and Oxidative Chemistry

Biotechnological processes are typically perceived to be greener than chemical processes. A life cycle assessment (LCA) was performed to compare the chemical and biochemical synthesis of lactones obtained by Baeyer-Villiger oxidation. The LCA is prospective (based on experiments at a small scale with primary data) because the process is at an early stage. The results show that the synthesis route has no significant effect on the climate change impact \((1.65\pm0.59) \text{ kg CO}_2 \text{ g product}^{-1}\) vs. \((1.64\pm0.67) \text{ kg CO}_2 \text{ g product}^{-1}\). Key process performance metrics affecting the environmental impact were evaluated by performing a sensitivity analysis. Recycling of solvents and enzyme were shown to provide an advantage to the enzymatic synthesis. Additionally, the climate change impact was decreased by 71% if renewable electricity was used. The study shows that comparative LCAs can be used to usefully support decisions at an early stage of process development.

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