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Large Scale Production of Polyhydroxyalkanoates (PHAs) from Waste Water: A Study of Techno-Economics, Energy Use, and Greenhouse Gas Emissions

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Abstract : The biodegradable family of polymers polyhydroxyalkanoates are interesting substitutes for convectional fossil-based plastics. However, the manufacturing and environmental impacts associated with their production via intracellular bacterial fermentation are strongly dependent on the raw material used and on energy consumption during the extraction process, limiting their potential for commercialization. Industrial wastewater is studied in this paper as a promising alternative feedstock for waste valorization. Based on results from laboratory and pilot-scale experiments, a conceptual process design, techno-economic analysis and life cycle assessment are developed for the large-scale production of the most common type of polyhydroxyalkanoate, polyhydroxbutyrate. Intracellular polyhydroxybutyrate is obtained via fermentation of microbial community present in industrial wastewater and the downstream processing is based on chemical digestion with surfactant and hypochlorite. The economic potential and environmental performance results help identifying bottlenecks and best opportunities to scale-up the process prior to industrial implementation. The outcome of this research indicates that the fermentation of wastewater towards PHB presents advantages compared to traditional PHAs production from sugars because the null environmental burdens and financial costs of the raw material in the bioplastic production process. Nevertheless, process optimization is still required to compete with the petrochemicals counterparts.

Keywords : circular economy, life cycle assessment, polyhydroxyalkanoates, waste valorization
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