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Abstract

Evaluation of the Parameters of Poly(Butylene succinate) Enzymatic Polymerization †

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Abstract: Poly(butylene succinate) (PBS) is a bio-based and biodegradable polyester that can be used in numerous applications, ranging from clothing to food packaging and from the car industry to the biomedical sector (e.g., drug release systems). The conventional polymerization method of PBS requires the presence of metal-based transesterification catalysts (e.g., titanium-based catalysts) and high reaction temperatures (T > 150 °C). However, under these conditions side reactions may occur along with undesirable yellowing. Green polymerization routes such as biocatalysis are being developed. However, there is a very limited literature on the enzymatic synthesis of PBS. Additionally, in most of the works where high-molecular-weight PBS is produced from the typical monomers (BDO and DES), several drawbacks, e.g., the use of various solvents for polymer isolation and the requirement of high vacuum for by-products removal may impede the process being scaled up. On that basis, an eco-friendly, solvent-free, enzyme-based process for the production of PBS was applied. It was conducted in two steps with the use of Novozym 435: the first at 40 °C, under atmospheric pressure for 24 h, and the second at 90 °C, 20 mbar for 2 h. This work focused on the optimization of the second step's conditions, by varying reaction temperature (80–95 °C), pressure (20 mbar, 200 mbar) and reaction time (2 h, 6 h). Based on the optimization results, the process was scaled up (ca. 10 g of product). A PBS grade free of thermal degradation and metal catalyst residues, of weight-average molecular weight 4700 g/mol and melting point 103 °C, was obtained.

Keywords: bio-based/biodegradable polyester; enzymatic polymerization; lipase; poly(butylene succinate)

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