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A Two-Stage Process for the Sustainable Production of Aliphatic Polyesters

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Abstract : A "green" process was studied for the preparation of partially renewable aliphatic polyesters based on 1,4-butanediol and 1,8-octanediol with various diacids and derivatives, namely diethyl succinate, adipic acid, sebacic acid, 1,12-dodecanedioic acid and 1,14-tetradecanedioic acid. A first step of enzymatic prepolymerization was carried out in the presence of two different solvents, toluene and diphenylether, applying molecular sieves and vacuum, respectively, to remove polycondensation by-products. Poly(octylene adipate) (PE 8.6), poly(octylene dodecanate)(PE 8.12) and poly(octylene tetradecanate) (PE 8.14) were firstly enzymatically produced in toluene using molecular sieves giving however, low-molecular-weight products. Thereafter, the synthesis of PE 8.12 and PE 8.14 was examined under optimized conditions using diphenylether as solvent and a more vigorous by-product removal step, such as application of vacuum. Apart from these polyesters, the optimized process was also implemented for the production of another long-chain polyester-poly(octylene sebacate) (PE 8.10) and a short-chain polyester-poly(butylene succinate) (PE 4.4). Subsequently, bulk post-polymerization in the melt or solid state was performed. SSP runs involved absence of biocatalyst and reaction temperatures (T) in the vicinity of the prepolymer melting point (Tm-T varied between 15.5 up to 4oC). Focusing on PE 4.4 and PE 8.12, SSP took place under vacuum or flowing nitrogen leading to increase of the molecular weight and improvement of the end product physical appearance and thermal properties.

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