The Development of Bioprocess for the Production of Polyhydroxyalkanoates

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ABSTRACT

The bio-polymer, PHBV (poly-hydroxybutyrate-co-hydroxy-valerate), with similar physical properties as polypropylene, is a kind of polyesters produced by microorganism. The application of PHBV is quite extensive because it is suitable for current polymer processing. Since PHBV can be biodegraded, its usage is even more significant for environmental protection. The Alcaligenes eutrophus was cultured at various concentrations of propionic acid to study the microbial growth rate, the PHBV accumulation, the consumption of carbon and nitrogen substrates during fermentation, and organic acid production due to metabolism. Results show that, under a low concentration of propionic acid, the solution contains 9.44 g biomass/L, in which 1.03 g/L are PHBV after 53.5 hr culture. The microbial growth rate is 0.1662 /hr and the specific PHBV production rate is 0.0084 g PHBV/g residual biomass · hr. The specific consumption rates of propionic acid and glucose are 0.0230 g propionic acid/g residual biomass · hr and 0.1259 g glucose/g residual biomass · hr, respectively. The melting point of PHBV obtained from a DSC analysis is 143.1 ℃, which indicates that the produced PHBV contains 21.4% of HV monomer. Under a middle concentration of propionic acid, the solution contains 4.00 g biomass/L, in which 0.86 g/L are PHBV after 51 hr culture. The microbial growth rate is 0.1291 /hr and the specific PHBV production rate is 0.0101 g PHBV/g residual biomass · hr. The specific consumption rates of propionic acid and glucose are 0.0303 g propionic acid/g residual biomass · hr and 0.1740 g glucose/g residual biomass · hr, respectively. The melting point of PHBV obtained from DSC analysis is 169.2 ℃, which indicates that the produced PHBV contains 1.0% of HV monomer. Under a high concentration of propionic acid, the solution contains 2.89 g biomass/L, in which 0.47 g/L are PHBV after 72 hr culture. The microbial growth rate is 0.1413 /hr and the specific PHBV production rate is 0.0227 g PHBV/g residual biomass · hr. The specific consumption rates of propionic acid and glucose are 0.0512 g propionic acid/g residual biomass · hr and 0.2748 g glucose/g residual biomass · hr, respectively. The melting point of PHBV obtained from a DSC analysis is 165.6 ℃, which indicates that produced PHBV contains 3.8% of HV monomer. The specific consumption rates of propionic acid and glucose increase with the concentration of propionic acid in the culture solution. At a final stage of fermentation, when the glucose concentration dwindles down to about 3.0 g/L, the glucose consumption become diminished.

Keywords : PHBV ; fermentation ; microbial growth rate ; specific PHBV production rate ; specific consumption rate of carbon substrate ; DSC analysis

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