The Research of Production of PHBV by a Continuous Stirred Tank Reactor

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ABSTRACT
PHB (POLY-HYDROXYBUTYRATE) and PHBV (POLY-HYDROXYBUTYRATE-CO-HYDROXY-VALERATE), having physical properties similar to polypropylene, is a kind of polyesters produced by microorganisms. The application of PHBV is quite extensive because it can be easily processed by current techniques. PHB and PHBV can be produced by many strains including Ralstonia eutropha, Alcaligenes latus, Azotobacter vinelandii, methylophilic sp., Pseudomonas sp., and recombinant DNA's Escherichia coli. A Continuous Stirred Tank Reactor (CSTR) is used to study the effect of limiting nutrients on the microbial growth and product accumulation. Ralstonia eutropha was cultivated by using a Continuous Stirred Tank Reactor with various dilution rates and concentrations of sodium propionate in the feeding substrates in order to explore the microbial growth, the PHBV accumulation, the consumption of glucose, nitrogen and sodium propionate substrates during fermentation. Results show that there is no hydroxyvalerate (HV) accumulation if the concentration of sodium propionate in the feeding substrates is less than 1 g/L. The higher the sodium propionate concentration is, the higher the HV molar fraction in the PHBV the biomass possesses. When sodium propionate was not yet fed, only PHB is accumulated in the biomass, and the average percentage of PHB in the biomass ranges from 35 to 41%, the highest percentage occurring at the dilution rate of 0.102/h. In the case of feeding substrate containing 1 g/L of sodium propionate, only PHB appeared in the product due to the low concentration of propionate. For this case, the percentage of PHB in the biomass ranges from 42 to 55%, and the highest occurred at the dilution rate of 0.1/h. In the case of feeding substrates containing 5 g/L of sodium propionate, HV began to accumulate in the product, and the highest percentage (about 78 wt.%) of PHBV in the biomass occurred at the dilution rate of 0.093/h. The average molar ratio of HB to HV is about 70:30. In the case of feeding sodium propionate at a concentration of 7 g/L, the biomass contains about 68 wt.% of PHBV at the dilution rate of 0.016/h, and the average molar ratio of HB to HV approximately maintained at 60:40. When the dilution rate was adjusted to 0.058/h, the biomass and PHBV reduced significantly. In the case of feeding a substrate containing 15 g/L of sodium propionate, the average molar ratio of HB to HV is maintained at 40:60, while the dilution rate was at 0.016/h. When two carbon sources coexist in the feed stream of a continuous flow system, R. eutropha can produce intracellular PHBV. The higher the concentration of sodium propionate in the feed stream is, the higher the molar fraction of HV in the product has. The dilution rate could reach 0.15/h to avoid a possible washout, when the sodium propionate concentration is less than 5 g/L. When the dilution rate is near 0.1/h, the PHBV produced by R. eutropha reached the highest concentration. The dilution rate could be as high as 0.028/h, and the system could still maintain a steady state if the concentration of feeding sodium propionate was 7 g/L. If the concentration reached 15 g/L, the steady state was hard to maintain even for a low dilution rate of 0.016/h. Although a higher feeding concentration of sodium propionate can promote the accumulation of HV, it may exhibit the growth of R. eutropha. Consequently, the biomass and PHBV production become low.

Keywords: PHBV, Continuous Stirred Tank Reactor, Sodium Propionate, Dilution Rate, Ralstonia Eutropha
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