Nonlinear impulsive system of fed-batch in fermentation productive and its optimal control

Caixia Gao[1], Enmin Feng[1], zhilong Xiu[2]

(1. Department of Applied Mathematics, Dalian University of Technology, Dalian, Liaoning, 116024, P. R. China. Email: gaocx0471@163.com, emfeng@dlut.edu.cn)

(2. Department of Biotechnology, Dalian University of Technology, Dalian, Liaoning, 116012, P. R. China. Email: zlxiu@mail.dlptt.ln.cn)

Abstract

Considering the sudden increase of the glycerol and alkali in fed-batch culture of glycerol bioconversion to 1,3-propanediol, this paper proposes a nonlinear impulsive system of fed-batch culture. The existence, uniqueness and regularity properties of solution for the system are proved. In view of the controllability of volumes of glycerol added to the reactor instantaneously, the paper constructs an optimal control model based on the nonlinear impulsive system and the existence of the optimal control is obtained. The control variables here are the sizes of jumps in the states at the discrete instants and the objective is to maximize the productivity of 1,3-propanediol over one cycle. The numerical results at the end show that the productivity of 1,3-propanediol can be maximized under the constraint that the total volume of the consumed glycerol is given.

Key words: fed-batch culture; nonlinear impulsive system; optimal control