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Modeling of fermentation process of *Bacillus thuringiensis* as a sporulating bacterium

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Sporulating bacteria constitute a large portion of industrial microorganisms. Many important bioproducts such as solvents, antibiotics, enzymes, and pesticides with applications in food, pharmaceutical, and chemical processes are produced by sporulating bacteria. *Bacillus thuringiensis* (*Bt*) is an aerobic, rod-shaped, and sporulating bacterium that during its sporulation process produces toxic crystal proteins, called delta endotoxins, which have insecticidal action. Due to the economic importance of this product, great efforts have been made to improve its operation and control procedures especially by means of mathematical models. As shown in Fig. 1, there are three distinct types of cells in a *Bt* culture: vegetative cells, sporangia, and mature spores. The aim of this work was to provide a mathematical model that can estimate the populations of these three types of cells. In this paper, a cell population balance model was used to represent the dynamic behavior of the process. An unstructured and non-segregated model was used for the dynamic fermentation process with 0%, 50% and 100% oxygen saturation in a fed-batch culture. The mathematical model consists of a partial differential equation (PDE) that describes the distribution of a cell population based on the cell age. To solve the mathematical model, the method of lines was used in MATLAB that approximates the PDE model by a set of nonlinear ordinary differential equations (ODEs). Then, the resulted ODEs were solved by the 4th order Rung-Kutta method. The results show that the proposed model can estimate the cell populations properly.

Biography

N Mostoufi is currently a Full Professor of Chemical Engineering at the University of Tehran. He has taught advanced mathematics and fluid mechanics courses for over 16 years. His research interests include process modeling, simulation and optimization, and fluidization. He holds a BEng and MSc degree in Chemical Engineering from Iran's University of Tehran and a PhD in fluidization from Canada's Ecole Polytechnique de Montréal. He has more than 270 publications in major international journals and conferences, plus five books and four book chapters. He is the Co-Author of the textbook *Numerical Methods for Chemical Engineers with MATLAB Applications*, published by Prentice Hall PTR in 1999. He is the Founder and Editor-in-Chief of *Chemical Product and Process Modeling* published by Walter de Gruyter GmbH, Germany and winner of University of Tehran's International Award, 2015. He is also the University of Tehran's distinguished Researcher, 2013.

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