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A comprehensive mathematical analysis of a novel multistage population balance model for cell proliferation

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Abstract

Multistage population balances provide a more detailed mathematical description of cellular growth than lumped growth models, and can therefore describe better the physics of cell evolution through cycles. These balances can be formulated in terms of cell age, mass, size or cell protein content and they can be univariate or multivariate. A specific three stage population balance model based on cell protein content has been derived and used recently to simulate evolution of cell cultures for several applications. The behavior of the particular mathematical model is studied in detail here. A one equation analog of the multistage model is formulated and it is solved analytically in the self-similarity domain. The effect of the initial condition on the approach to self-similarity is studied numerically. The three equations model is

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