Modeling and prediction of cell population dynamics

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Oscillatory yeast cell dynamics are observed in glucose-limited growth environments. Under such conditions, both glucose and the excreted product ethanol can serve as substrates for cell growth. The cell dynamics is described by a PDE (partial differential equation) system containing one PDE for the cell population and 8 ODEs for 8 substrates variations (extracellular glucose, extracellular ethanol, intracellular glucose, intracellular ethanol, exhausted oxygen, exhausted carbon dioxide, dissolved oxygen and dissolved carbon dioxide).
The system is solved by the numerical method of characteristics (MOC). The modified MOC provides a solution free of numerical dissipation error caused by the cell growth term (i.e., convection term), owing to the mass axis moving along a cell growth pathline.
The oscillatory behavior of the cell number and the cell mass is predicted from the simulation. The cell number variation affects the extracellular glucose/ethanol and oxygen/carbon-dioxide concentrations in the gas exhaust stream. Dynamics of the evolved oxygen concentration ratio and carbon-dioxide concentration ratio are also shown.