



Transcritical-like Bifurcation in a Model of a Bioreactor

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Abstract: A non-standard bifurcation, similar to a transcritical one, in a model of a bioreactor has been detected. This happens in a periodically-forced system with restrictions on the state space. The bioreactor is periodically fed with substrate. In the mathematical model, a periodic orbit approaches (without hitting) the restriction surface as a bifurcation parameter is varied. The way the orbit approaches the switching surface in the three-dimensional state space is such that it becomes parallel to the restriction surface. This phenomenon is somehow analogous to a transcritical bifurcation since another periodic orbit exists inside the restriction surface, but they do not collide. Full model and bifurcation description are shown.

Keywords: *bifurcation; bioreactor; periodically-forced; nonlinearity.*

Mathematics Subject Classification (2010): 34C23, 34C25, 34D20, 37C27.

1 Introduction

The biological wastewater treatment uses different techniques to create optimum environmental conditions that promote the removal of organic matter by using microorganisms. One of the most common is the activated sludge system, which uses aeration for bacteria [1, 2].

A least-used system, although it is a current research topic, is the Anaerobic Digestion, which operates in the absence of oxygen. The UASB (Upflow Anaerobic Sludge Blanket, or Upflow Anaerobic Reactor) is a type of tubular bioreactor operating in continuous mode and in upflow. These systems have an additional advantage because they can treat effluents with high organic load wastewater from agriculture and food industry tasks. The

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