531g The Influence of Kinetic and Spatial Segregation on Fate of Commensalistic Cultures

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Steady state and dynamic behavior of mixed cultures with one way interaction is investigated in two coupled reactors. The substrate (resource) required for the growth of the host species is generated by extracellular products of the growth, providing thereby a kinetic feedback. The steady states are divided into three types. For the form of kinetics considered, the two reactors can operate at up to forty nine steady states, the maximum number of steady states for a single reactor being seven. Criteria for admissibility and stability of different steady states are derived analytically. Admissibility of cyclic states is investigated. The specific example considered pertains to anaerobic digestion of insoluble organics by acid generating and methane generating bacteria. For specific kinetic parameter set, the operating parameter space is divided into multiple regions based on admissibility of various steady states and dynamic characteristics. The formulation considers identical and different attributes (feed rates, feed composition, reactor size, and rates of exchange of material between the reactors) for each of the reactors. In this work, numerical simulations have been employed to study the effect of these attributes on coexistence of the two populations and performance of the two-reactor assembly. The bifurcation analysis of the two reactor system reveals a rich behavior in terms of number of steady states admissible, and their profiles under the effect of variation of operating parameters. This configuration permits the multiplicity of ``stable'' coexistence steady states. It is also demonstrated how this multiplicity imparts significant robustness to the system. Certain sub-configurations of the coupled reactors case were found to allow for an extended region of operation in the operating parameter space, thus providing increased operating flexibility.