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A model of a hybrid shortcut nitrification process

Nitrogen removal is a key process in the treatment of wastewater but, in systems with low carbon influent streams, complete denitrification is difficult without supplementary organic carbon. The discovery of microorganisms that can oxidise ammonium directly to nitrogen gas under anaerobic conditions using nitrite as the electron acceptor has led to a significant change in the design of nitrogen removal. This process, Anammox (AMX), has been coupled with partial nitritation (PN/A), the incomplete nitrification of ammonium to nitrite, for cost-effective treatment of ammonium rich waste streams. However, these systems are far from ideal, given the dynamics and characteristics of the functional groups involved in the process. To overcome the issues of substrate competition and imperfect control of the undesired Nitrite Oxidisers (NOB) under mainstream operation, hybrid systems have been developed that assume perfect segregation between the AMX, retained as a biofilm in the reactor, and the Ammonia Oxidisers (AOB) and NOB, which form flocs and are subject to selective washout. A mathematical model of the PN/A model developed previously as a series of ODEs with some gross assumptions is analysed as both a Sequencing Batch Reactor with impulsive differential equations, and as a conventional CSTR. The existence and stability of equilibria in the CSTR to describe the behaviour of *r* and *K strategists*, and some discussion on the analysis of the impulsive system are given.