Hybrid Modelling of a PHA Production Process Using Modular Neural Networks

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Abstract
A novel method for bioreactor hybrid modeling is presented that combines first principles models and modular artificial neural networks trained with the Expectation Maximization (EM) algorithm. The use of modular networks was motivated by the nature of the ‘cells system’ that may be viewed as a highly complex network of metabolic reactions organised in modular pathways. The proposed hybrid modelling technique is validated experimentally with a laboratory scale Polyhydroxyalkanoates (PHAs) production process. The main results show that the embedded modular network, if trained with the EM algorithm, is able to organise itself in modules that have correspondence to the underlying biological pathways. In the particular case of the PHA process discussed, the network learned to discriminate between acetate and internal reserves respiration, with the smaller network modules developing expertise in describing the reaction kinetics of the one or other metabolic state.

Keywords: hybrid modelling, modular neural networks, fermentation processes