

过程系统工程

关键核网络及其在发酵过程在线建模中的应用

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摘要

发酵过程通常采用流加补料操作, 无稳态工作点、非线性强, 且重要生物量往往无法在线测量。本文提出了一种适用于非线性多输入多输出的发酵过程在线建模方法: 关键核网络 (key kernel network, KKN)。结合过程的先验知识给出控制模型关键节点加入的准则, 使其能自适应调整模型的复杂度, 以提高建模的精度和速度, 并给出了关键节点增加时KKN模型的在线递推形式。将KKN应用于青霉素发酵过程的在线建模, 研究表明, KKN能同时快速、准确地预报菌体和产物浓度, 且随着批次的增加, 过程信息不断得到积累, 模型精度逐渐提高。

关键词

[核学习](#) [在线建模](#) [流加补料](#) [青霉素发酵过程](#)

分类号

Key kernel network and its application to online modeling for fermentation processes

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Abstract

Modeling and control of fed-batch fermentation processes are inherently difficult due to the characteristics of complex non-linearity, non-steady-state behavior and batch-to-batch variation. Moreover, the process variables are always hard to measure online and the quality of the product is difficult to define. A novel key kernel network (KKN) was proposed for online modeling of nonlinear MIMO processes. The model complexity could be controlled by the criterion of only adding the "key nodes" to the learning machine; further, the prior knowledge of the process could be easily combined. Consequently the generalization ability and modeling speed were improved. The forward learning of KKN was efficiently updated whenever a new key node was introduced. The proposed KKN was applied to the online modeling of fermentation processes. The simulations on the fed-batch penicillin fermentation process showed that the biomass and penicillin concentrations could be predicted simultaneously with high precision and fast learning ability. Furthermore, the modeling precision can be improved because the process knowledge could be accumulated batch-to-batch.

Key words

[kernel learning](#) [online modeling](#) [fed-batch cultivation](#) [penicillin fermentation process](#)

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