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Control Structure Selection for the ALSTOM Gasifier Plant Considering Model Plant Mismatches

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Abstract: Relative disturbance gain array (RDGA) is a very useful tool for assessing the disturbance rejection capability of decentralised control structures. However, the values of RDGA are affected by model uncertainties. An optimization based method for determining RDGA ranges for systems with model uncertainties is presented. And the method is applied to the control structure selection for the ALSTOM Gasifier benchmark problem. Reduced order linear process and disturbance models of the gasifier are identified from simulated plant operating data using the output error system identification method. Several models are identified under different operating conditions and model uncertainty bounds are obtained from those models. The generalized relative disturbance gain ranges of the ALSTOM gasifier under model uncertainty are calculated and used in selecting robust decentralized control structure.

Key words: ALSTOM gasifier; relative disturbance gain array; plantwide control; process control; model plant mismatch

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模型过程差异下的 ALSTOM 气化装置控制结构选择

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摘 要: 相对扰动增益矩阵是分析控制结构抗干扰性的一个有用工具, 但它的结果受模型不确定性影响。提出基于优化来确定相对扰动增益矩阵范围的方法并用来选择 ALSTOM 气化装置的控制结构。利用过程运行仿真数据和输出误差系统辨识方法得到降阶线性模型。在不同运行状况统辨几个模型并通过这些模型得到模型不确定性范围。计算出 ALSTOM 气化装置在模型不确定性下的广义相对扰动增益范围并用来选择鲁棒控制结构。

关 键 词: ALSTOM 气化装置; 相对扰动增益矩阵; 全厂控制; 过程控制; 模型过程差异

1 Introduction

In 1997 the ALSTOM Power Technology issued an open challenge to the UK academic control community, which addressed the control of a Gasifier plant[1]. The "challenge information pack" included three linear models (obtained from ALSTOM's comprehensive nonlinear model of the plant). Among the approaches that have been proposed to solve this challenging problem, Asmar et al.[2] provide a relatively simple controller structure but with excellent performance. Later this structure was adopted and used as the baseline controller in the second round of ALTOM benchmark challenge[3], where the nonlinear simulation programme for the process is provided. However, detailed analysis on why this baseline control structure performs well has not been reported. This paper presents an analysis of the disturbance rejection capability of various control structures for the ALTOM benchmark considering model uncertainties.

Relative gain array (RGA)[4] and Niederlinski Index[5] have been commonly used for control structure determination. The popularity of RGA is mainly because of its simplicity and confirmed reliability in many case studies. However, RGA has been known to have some deficiencies as it does not consider dynamic and

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