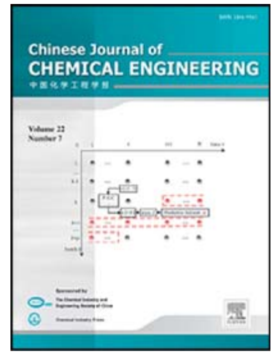

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Feasibility analysis and online adjustment of constraints in model predictive control integrated with soft sensor

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Abstract

Feasibility analysis of soft constraints for input and output variables is critical for model predictive control(MPC). When encountering the infeasible situation, some way should be found to adjust the constraints to guarantee the optimal control law exists. For MPC integrated with soft sensor, considering the soft constraints for critical variables additionally makes it more complicated and difficult for feasibility analysis and constraint adjustment. Therefore, the main contributions are that a linear programming approach is proposed for feasibility analysis, and the corresponding constraint adjustment method and procedure are given as well. The feasibility analysis gives considerations to the manipulated, secondary and critical variables, and the increment of manipulated variables as well. The feasibility analysis and the constraint adjustment are conducted in the entire control process and guarantee the existence of optimal control. In final, a simulation case confirms the contributions in this paper.

Keywords: Soft sensor; Model predictive control; Variable constraints; Feasibility analysis

1. Introduction

In chemical processes, some critical variables indicate the production quality directly and play an indispensable role in process control. The lack of real-time measurement technique leads to scare measurements for these variables. As a powerful alternative, soft sensor technique has been proposed and developed rapidly in the last two decades [1-3].

On the basis of the soft sensor model for easily measured variables(defined as secondary variables, such as pressure, temperature, et al.) and the critical variables, it is possible to predict the critical variables in real-time, and in the meanwhile achieve direct control for production quality[4]. Model predictive control(MPC) is an advanced control approach[5-7]. The most significant advantage of MPC is the ability to solve optimal control problem for multi-variable systems with constraints for input and output variables[8,9]. However, little deep research on the combination of soft sensor technique and MPC has been reported so far, and more studies focus on the applications of them[10-12].

Generally, the input and output variables are restricted with hard and soft constraints in actual control. The hard constraints are related with physical condition; the soft constraints reflect control requirements and could be adjusted online. MPC is actually solving quadratic programming with soft constrain conditions. If the soft constraints are feasible, optimal control could be obtained; otherwise, they need to be adjusted until feasible condition is reached. Thus, analyzing the

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