学校编码：10384

学号：X2011223010

厦门大学

硕士学位论文

模型预测温度控制器的设计及PLC实现

Design and PLC Implementation of Model Predictive Controller

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专业名称：控制理论与控制工程

答辩日期：2015年12月

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摘　要

模型预测控制（MPC）是一个可行的工业过程控制算法，适用于拥有变化参数，多变量耦合及大滞后的被控过程。使用MPC控制器是为了使煮糖生产过程运行稳定，提高煮糖过程的精度和效率。本文研究重点是设计一种MPC的控制器，能够直接在可编程逻辑控制器及相应平台上实现。虽然目前已经有许多MPC控制器在工业应用中实践运行，但仍没有控制软件包在工业控制系统中最常见的三菱PLC平台实现基于模型预测的控制技术。本文设计基于三菱PLC实现的MPC反馈控制器——MSF控制器，并与PID控制器的控制效果相比较。并从以下三个主要方面比较两种控制器的性能：初始状态下每个控制器的动态响应，包括温度的上升时间和超调量，以及各控制器的干扰抑制能力。试验结果表明，MPC控制器控制煮糖过程比以PID控制方法对温度的上升时间，超调量，干扰抑制能力更好。而且，采用基于三菱PLC实现的MPC控制器无需额外的硬件，软件和通讯协议，成本更低且易于维护。

关键词：时滞；模型预测；PLC

Abstract

Model Predictive Control (MPC) is a viable control strategy for industrial processes that display relatively large variations in process variable, have complex process variable interactions, or display a large amount of process dead time.

The objective of using MPC in manufacturing is to reduce overall process variability, the result being an increase in process accuracy, precision and efficiency. This study focused on the implementation of MPC techniques on an industrial sugar cooking process. The goal was to implement a successful MPC solution directly on a PLC. Although there are many available MPC controllers for implementation on a stand-alone PC, to date there are no soft control packages for realizing MPC techniques directly on a PLC. The study implemented and evaluated a new model state feedback (MSF) MPC implementation directly on Mitsubishi's PLC. A standard PID control implementation was used as a baseline for comparing the MPC strategies. There are three main areas on which the overall comparative analysis focused. These areas were the dynamic response of each strategy at startup, including both temperature rise time and overshoot, and the steady-state disturbance rejection capabilities of the strategy.

The test results showed that the MPC strategy is better than PID strategy in regards to temperature overshoot, temperature rise time and disturbances rejection on feed rate disturbance. However, this strategy has several benefits such as requiring to no external hardware, software and communications protocols. The PLC-based strategy is also easier and cheaper to maintain because it is developed on the existing, well-known control platform with existing tools.

Keywords: Dead TimeModel Predictive ControlPLC

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