

**Department of Chemical Engineering
University of California, Santa Barbara**

ChE 152B

Winter, 2010

Lab 4: Model Predictive Control

1. Introduction

In Lab 4, you will be introduced to the model predictive control algorithm. You will design and implement an MPC controller for the 4-Tank System based on a previously identified process model.

2. Pre-Lab Analysis

From the previous labs, you will have an empirical approximation of the 2x2 transfer function matrix between the pumps and tanks. Using this model, generate a set of 4 unit step response curves (one for each i/o pairing). Plot the step response curves in a 4x4 array in MATLAB. Be sure to set the axes to give clear responses.

Using the Simulink files provided, design and tune an MPC controller, and test it in simulation.

3. Experimental Activities

Using the model identified in the last section, you will import the model into the MPC controller (instructions will be provided in lab) in the Simulink file *modelPredictiveController.mdl*. There are a number of degrees of freedom (tuning knobs) in the MPC block; we will focus on the move suppression (input penalty) term for tuning in this lab module.

You should consider 3 different values for the move suppression parameter in the range [0.1, 10]. These will lead to 3 different MPC designs that you will need to evaluate.

Perform the following steps to evaluate each of your controllers.

- Implement MPC controllers, and subject the tanks to individual setpoint changes as well as simultaneous setpoint changes (different “directions” would be interesting – think of the 2 setpoints in the X-Y plane). Consider at least 4 overall setpoint changes in your experiment.
- Repeat the same setpoint sequence for each of the three (tuning) designs.

4. Lab Report

In your lab write-up, be sure to interpret carefully the results you obtained, and where possible make a connection to the physical model. Draw contrasts between the behavior of the different controller tuning, and compare to the previous results using decoupled SISO designs (Lab 3). Be sure to make a final recommendation for your preferred design (& tuning).

In addition, make some recommendations for additional experiments you might have performed (time permitting) such as alternative tuning of the MPC controller (including other tuning knobs, etc.).

5. Appendices

- PCM
- Model parameters obtained in system identification (lab 1)
- M-code for generating step response models
- Matlab instructions for simulation study and lab experiments