Department of Chemical Engineering
University of California, Santa Barbara

ChE 152B **Winter, 2010**

Lab 3: Decoupling Control

1. Introduction

In this lab you will design and evaluate several types of decoupling control strategies for the 4-Tank System. Two control strategies from Chapter 18 of the textbook will be considered:

a. Static decoupling
b. Partial (one-way) dynamic decoupling to improve h_1 control.

2. Pre-lab Analysis

Prior to Lab 3 you should select the best multiloop PI control settings based on the results from Lab 2. For each of the two decoupling design methods of Section 1, design the decouplers based on a transfer function model. The design objective for the partial decoupler is to improve the control of liquid level h_1. If a theoretical decoupler is not physically realizable, suggest an appropriate approximation that can be implemented.

3. Experimental Activities

Important: Be sure to record all transient responses and other relevant information, such as controller settings and bypass valve positions. Also, back-up your experimental data to a disk or flash memory unit, as well as a folder on the hard drive. You may need to access the data during future experiments.

Evaluate a standard multiloop PI control system using *decoupling.mdl*:

a. Set both pumps at 55%. Record the steady-state values of h_1 and h_2.
b. Implement your best PI multiloop controller settings from Lab 2. (If they were not satisfactory, attempt to fine tune them at this time.)
c. Evaluate your best multiloop controller settings for a small step change in h_{1sp} (e.g., 2 cm).
d. After the process reaches steady state, introduce a step disturbance by partially closing the upper bypass valve for Tank 3. Record the new bypass valve setting.

Evaluate each of the two decoupling control systems of Section 1 by repeating Steps (c) and (d). If a decoupling control system does not perform well, attempt to fine tune it. Which controller results in the best control for the setpoint changes? For the step disturbance?

4. Lab Report

Analyze your results and prepare a lab report using the Memo/Personal File format described in previous handouts. (Recall the limits on the maximum numbers of figures and tables in the Memo.) Tabulate your controller settings and metrics of control system performance for the different control systems. Which controller provided the best results for the h_1 set-point change? For the step disturbance? Justify your answers using the results in the table. Was liquid level h_2 significantly upset after h_{1sp} was changed?

Your memo should include two plots comparing the experimental h_1 and h_2 responses with the corresponding simulated responses for the physical model. Perform this comparison for both your conventional multiloop control system and your best decoupling control system.