

Process Control Challenge: Develop a pH Process Simulator and Design a Feedback Controller to Control pH

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Organizers: Chemical Engineering Club

1 Overview

The goal of this hackathon challenge is two-fold: (a) to reproduce and validate the pH process simulator described by Choi et al. [1], and (b) design a feedback controller to regulate pH. Participants will develop a dynamic simulator of a continuous stirred-tank neutralization process, validate its steady-state and dynamic behavior against published results, and design a feedback controller to regulate pH in the presence of various disturbances.

2 Hackathon Tasks

Participating teams must implement the following tasks:

1. **Develop the pH process simulator:** Develop the dynamic simulator described in Choi et al. [1] for the continuous neutralization process. Use Simulink or an equivalent modeling environment (MATLAB/Python) to construct the model.
2. **Validation of Steady-state Simulation Results:** Simulate the steady state response of the system. Validate your simulator against any one steady-state case provided in the paper (that is, reproduce Figure 7 (or) Figure 8 (or) Figure 9).
3. **Validation of Dynamic Simulation Results:** Simulate the dynamic response. Validate the dynamic response of your simulator by reproducing any one dynamic result from the paper (that is, reproduce Figure 10 or 11). Your simulation should reproduce the three data trends shown in the paper: (1) deterministic process output, (2) process output with sensor lag, and (3) process output with sensor lag, drift and noise.
4. **Controller design:** Design and implement a controller to regulate pH in the simulated plant. The controller should use the measured pH (sensor output including lag, noise and drift). Provide closed-loop simulation results for the step and ramp-like disturbances and compare closed-loop performance metrics (RMSE, MAE, Cumulative Control Effort).

3 Deliverables

Each participating team must submit the following at the end of the hackathon deadline:

1. Source files for the simulator (Simulink .slx or MATLAB/Python code) with clear instructions to run the simulations. Model parameters given in the paper should be used as default values. The code or Simulink files should be self-contained (that is, NO user inputs for running the simulations and scripts). Your files should be saved in the following format: "TEAMNAME_TASK1_MAIN". This means it is the main file to answer Task1 of the Hackathon. Therefore, your final submission will contain 4 **main** files. You must also submit all your supporting files.
2. A short presentation (8–10 slides) summarizing key results.

4 Instructions

- Make suitable assumptions (wherever necessary) and state them clearly in your presentation.

References

- [1] JY Choi, HG Pandit, RR Rhinehart, and RJ Farrell. A process simulator for ph control studies. *Computers & Chemical Engineering*, 19(5):527–539, 1995.