162d Twin-Screw Food Extruder: a Multivariable Case Study for a Process Control Course

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Process control is sometimes viewed as an abstract mathematics course, particularly if the instructor does not make a substantial effort to incorporate realistic examples into the course. For a number of years we have incorporated case study projects to tie-together many of the basic process control concepts taught in a required course on process control taken by junior-level chemical engineering and environmental engineering students. We find that students are more motivated when they select a case study from an industry that is directly of interest to them.

In this paper we provide details on a case study module of a twin-screw food extruder. Students first conduct a literature review so that they understand the basic technology. They then download a SIMULINK (MATLAB) model file that represents the dynamic behavior of the extruder. Students perform step tests on the "plant" and develop transfer function-based models to use for control system design. They then design independent single-input, single-output (SISO) controllers by closing one loop at a time. Relative gain analysis (RGA) is used to suggest the proper input-output pairings to use when two control loops are closed simultaneously. Variable scaling and a singular value decomposition (SVD) analysis reveal that this is a well-conditioned system, from a steady-state perspective. A major limitation to the closed-loop performance of the multivariable system is the presence of a right-half-plane transmission zero, which the students find using a standard MATLAB command.

Instructors interested in using this module in their process control course will be provided with SIMULINK files, as well as an example report and project presentation.