



Guide to Selected Process Examples

Because of the strong interplay between process dynamics and control performance, examples should begin with process equipment and operating conditions. To this end, several process examples are introduced in the beginning chapters and used in many subsequent worked examples and questions. This approach has three advantages. First, the performance of different control approaches (e.g., tuning or control algorithm) can be evaluated on the same processes, allowing clear comparisons of competing methods. Second, the reader can concentrate on the learning objective applied to a familiar process. A final advantage is the reduction in the size of the book, since each example takes considerable space to introduce completely.

Since the reader may want to review the control approaches applied to a process, this guide is provided. Major worked examples and questions involving the most important processes are summarized in the tables. The symbols used in the tables are Ex for a worked example, Q for a question at the end of a chapter, S for a chapter section, F for a figure, and T for a table; as elsewhere, the number (or letter) before the period indicates the chapter (or appendix).

G.1 | HEAT EXCHANGER

This is a simple model of a heat exchanger. Since the process fluid side is well mixed and the utility side is at quasi-steady state, the basic model is first-order, which allows some analytical solutions to be determined. See Table G.1.





APPENDIX G Guide to Selected Process Examples

TABLE G.3 Nonisothermal CSTR

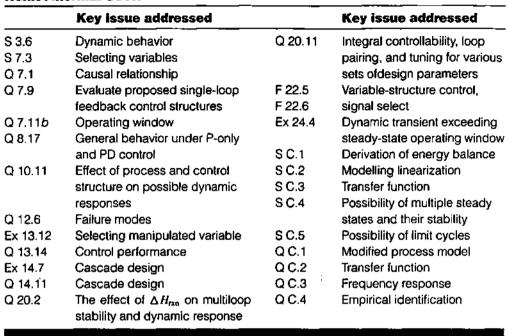


TABLE G.4
Two-product distillation column

	Key issue addressed		Key issue addressed
Q 2.8*	Effect of distribution on profit	Ex 21.3	Effect of disturbance type on
Q 2.9*	Effect of distribution on profit		multiloop control performance
S 5.6	Model development	Ex 21.6	Relative gain and loop pairings
Ex 5.4	Simulated dynamic response	Ex 21.9	Match tuning with performance
Q 6.10	Process reaction curve		goals
Q 14.6*	Cascade control	Ex 21.10	Decoupling, perfect and with
Ex 15.7*	Feedforward control		model errors
\$ 17.5*	Inferential tray temperature	Q 21.1*	Tuning, loop pairing,
Ex 20.2	Linearized model		performance and decoupling
Ex 20.4	Operating window	Q 21.8*	Tuning, loop pairing,
Ex 20.5	Evaluation of controllability		performance and decoupling
Ex 20.7	Effect of interaction on the	Q 21.11°	Control loop pairing
	changes in manipulated variable	Ex 23.1	Complexity of analytical inverse
Q 20.9°	Controllability, interaction, tuning	Ex 23.6	DMC control
Q 20.15°	Controllability, interaction, tuning	Ex 23.8	QDMC control
Ex 21.2	Effect of control structure on mul- tiloop control performance	Appendix J	Control Design

HEAT EXCHANGE AND FLASH DRUM



Thash drum at controlled pressure and temperature is a simple method for effecting a physical separation of components with different vapor pressures. This process provides the opportunity to evaluate inferential control and pair loops for dynamic performance. See Table G.6.

TABLE G.5
Two isothermal CSTRs

	Key issue addressed		Key issue addressed
Ex 3.3	Derive process model and evaluate a step response	Q 9.10	Effect of changing temperature on tuning
Q 3.14 Ex 4.6	Pulse response Solve step response using Laplace	Ex 10.4	Roots of closed-loop characteristic equation (modified process)
Ex 4.8	transforms (slightly modified model) Stability	Ex 10.8	Repeat Ex 10.4 with additional dead time
Ex 4.9 Ex 4.11	Derive the transfer function Damping	Q 10.11	Effect of process and control structure on possible dynamic responses
Ex 4.12 Ex 4.16	Block diagram Frequency response	Ex 13.8	Effect of inverse response on control performance
Q 4.1 Q 4.7	Emergency response Modified inputs	Q 13.18	Effect of an alternative manipulated variable on control performance
Q 4.16	Derive model and dynamic response for a different input variable	Q 15.11	Effect of dynamics on feedforward- feedback control
Q 5.4 Q 7.3	Four series reactors Causal relationship	Q 21.10 Ex I.2	Multiloop control Model with solvent flow adjusted
Q 7.11 <i>c</i> Q 8.15	Operating window Loop behavior	Q 1.3 Q 1.4	Model with F_A adjusted Control design

TABLE G.6 Heat exchange and flash drum

Key issue addressed		Key Issue addressed
Control system components	Ex 24.5	Degrees of freedom
Control objectives	Ex 24.6	Controllability
Inferential variable evaluation	Ex 24.7	Operating window
Model analysis	Ex 24.8	Loop pairing
Controllability	Ex 24.9	Algorithm selection and tuning
Loop pairing	Ex 24.10	Control for safety
Control design form (CDF)	Ex 24.11	Process monitoring
Sensors	Ex 24.12	Dynamic performance
Control objectives	Q 24.22	Partial control
Final elements		
	Control objectives Inferential variable evaluation Model analysis Controllability Loop pairing Control design form (CDF) Sensors Control objectives	Control objectives Ex 24.6 Inferential variable evaluation Ex 24.7 Model analysis Ex 24.8 Controllability Ex 24.9 Loop pairing Ex 24.10 Control design form (CDF) Ex 24.11 Sensors Ex 24.12 Control objectives Q 24.22