Inprocess Technology & Consulting Group, S.L.
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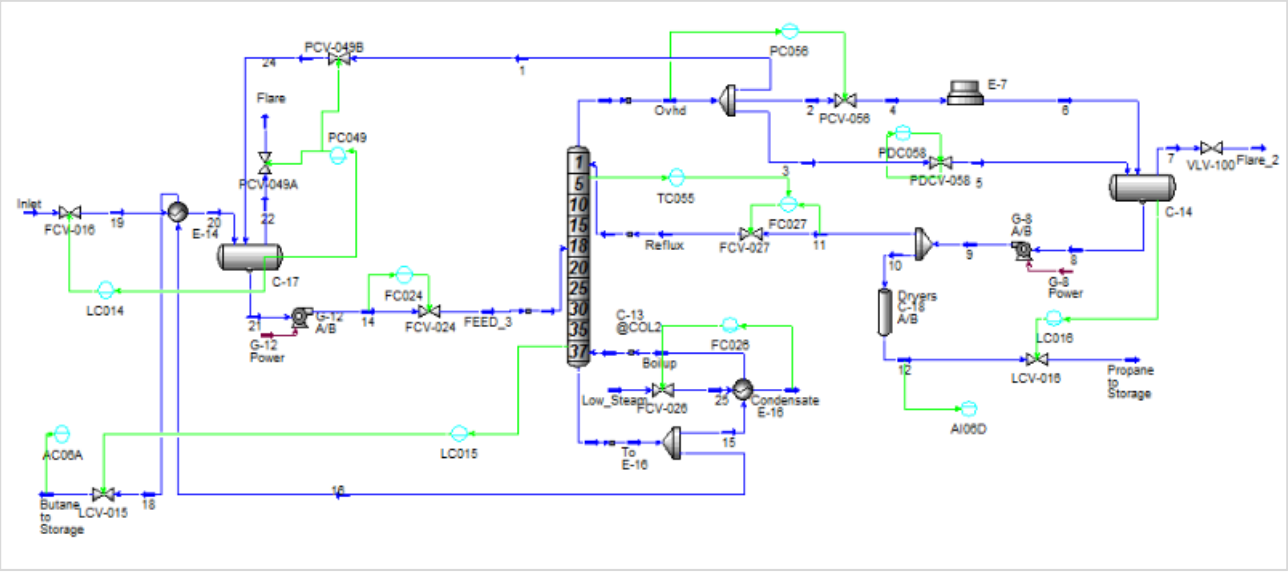
SC-DS02: Simulation for Process Control Engineers

Objectives

Process Engineers are heavy users of simulation tools (Aspen HYSYS®, Aspen Plus®, Honeywell UniSim®, etc.) to design new processes or revamps, and mostly all simulation training courses are designed for them. On the other hand, there are almost no specific simulation courses targeted for process control engineers, who can make use of the simulation tools to perform specific control tasks with the help of a simulator.

This course is conceived with the following objectives in mind:

- Learn the basic use of a steady-state simulator and their uses in process control (Gain calculation, property calculation, inferential development, etc.).
- Given a steady state model, be able to convert it to a dynamic model with the associated control loops (i.e.: distillation column).
- Given a dynamic model, be able to change the control loops configuration to perform dynamic analysis.
- Make use of all the control features included in a dynamic simulator (i.e.: On/Off, PID, Feed-forward, split-range, selector, transfer function, etc.).
- Make use of the tools and tricks inside the dynamic simulator to carry out process control analysis.
- All the modules of the course are 100% practical and every attendee is individually using the simulator in his/her own PC, it is a "learn by doing" course. The instructor will only spend 5-10 minutes at the beginning of every the module to explain the exercises in the manual of the course.
- All the modules are developed over the same distillation column, which has been taken from a real column of an existing plant. Therefore, real plant problems and constraints when attempting to simulate plant units are reproduced (lack of data, required detail, lack of time, etc.).



PARTICIPANTS

This course is aimed at process control engineers who are involved in the design, implementation and operation of any control system in a plant. No previous contact with process simulation software is required. The attendee should know basic chemical engineering principles (or equivalent plant experience) and process control fundamentals. It is also desirable knowledge of control/operation of distillation columns and 1-2 years of experience in process control roles.

CONTENTS

During the course, control engineers will learn the fundamentals of Steady State and Dynamic Process Simulation concepts and will practice with them, always from the point of view of a Control Engineer. The concepts acquired during the course will allow control engineers to make use of simulation tools for the development of basic and advanced control layer. The modules are prepared to approach the analysis to the given process making use of the different features of the simulator such as the Case Study to calculate gains or the event scheduler that will led to perform different case scenarios to see how the model behaves. Furthermore, the exercises show how to extract and use the available data in order to take the best advantage of the software capabilities. Some of the features that will be seen in the course are related to: distillation columns, sensitivity analysis, control strategy (feed forward, ratio controllers, split-range, master/slave…), function blocks, etc.

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THREE-DAYS COURSE AGENDA

MODULE	MODULE TITLE AND SHORT DESCRIPTION	TIME	DAY
1	CREATING A STEADY-STATE MODEL A simple steady-state case of a real distillation column is created from basic data available at the plant. Details about simulator user interface, workflow, etc. Using different column specifications (reflux ratio, tray temperature, purity, etc.) to reproduce the degrees of freedom of the column. Use of mixers/tees to reproduce feed compositions. Extracting and visualizing data from the model (column profiles, tables) as a function of a variable.	4 hours	Day 1
2	USING A STEADY-STATE MODEL FOR GAIN ANALYSIS AND PROPERTY ESTIMATION Configuration of the "Case Study" functionality inside the simulation to perform sensitivity analysis of the built column for independent vs. dependent variables. Extraction of the data to Excel. Calculation of the Steady-State gains and non-linearity of the process. Another sensitivity analysis over the column is performed in order to obtain a regression of the product quality based on column pressures and temperatures.	3 hours	
3	TRANSITIONING A STEADY-STATE MODEL INTO A DYNAMIC MODEL Discussion of the main differences between the two simulation modes (Steady-State vs Dynamic) with regards to specifying equipment and flowsheet details. Concepts of Dynamic Simulation: Pressure-Flow solver, Pressure nodes, resistance equipment, etc. Rules for transitioning from a solved steady-state model to a dynamics one. Transition of the distillation column model to Dynamics mode. The column is ready for the next day to be operated with all the valves in manual mode.	4 hours	Day 1 / Day 2
4	ACTIVATING PID CONTROLLERS IN THE DYNAMIC MODEL Operation of the column in Manual mode for few minutes. Introducing basic PID controllers and split range controller into the model for automatic mass-energy balance regulation. Use of faceplates and trending stripcharts. Introduce basic perturbations to the model. Simulator PID object features. Basic tuning of column PID controllers. Optional: use of a commercial tuning tool.	3 hours	Day 2
5	CONFIGURING AN ON-OFF CONTROLLER Learn how to build and configure on-off controllers.	0.5 hour	
6	CONFIGURING A MASTER-SLAVE CONTROLLERS Learn how to build and configure cascade controllers in the distillation column model and test their benefits. Level-Flow control. Tray temp-reboiler duty control. Tune the new cascades.	1.5 hours	
7	CONFIGURING RATIO CONTROLLERS AND SELECTOR BLOCK Learn how to build and configure in the distillation column a Ratio controller and override logic structures for different operation purposes.	1 hours	
8	CONFIGURING A FEED-FORWARD CONTROLLER Learn how to build and configure a Feed-forward controller for the reboiler duty to anticipate column load changes.	1 hour	

MODULE	MODULE TITLE AND SHORT DESCRIPTION	TIME	DAY
9	USING THE TRANSFER FUNCTION BLOCK Learn the multiple purpose uses of the transfer function block (TFB). Using TFB as signal generator for perturbations. Using TFB as a noise generator. Using TFB as a dead-time in analyser signal. Create a filter for a process variable in a spreadsheet.	2 hours	Day 3
10	ADDING DETAILS TO THE DYNAMIC MODEL Learn how to configure a number of useful options in the simulator to increase the fidelity of the model with the real plant. This includes: Valve Characteristic, Elevation and hydraulic Static Head contribution, equipment nozzles, level taps, actuators of the control valves, heat losses, and valve stiction.	2 hours	
11	USING THE EVENT SCHEDULER Learn how to configure the event scheduler to run automatically a sequence of events, for example to simulate a sequence of automatic steps for MVs-FFs.	1 hour	
12	EXTRACTING DATA FROM THE DYNAMIC SIMULATION Learn how to configure the case to perform simulation runs and extract the data in formatted files.	1 hour	
13	IMPORTING EXTERNAL PROCESS DATA TO THE SIMULATION Learn how to configure and use a simulation macro to import historic process data from an Excel file as a boundary condition or controller Set-Point of a dynamic simulation. Applied case to the Feed Flow of the distillation column.	2 hours	
14	COMPARING PERFORMANCE OF TWO DIFFERENT CONTROL LAYOUTS Learn how to duplicate the dynamic process model to compare simulation runs with different control settings. Applied case to the built distillation column.	1 hour	
15	CONFIGURING SIMULATED INFERENTIALS IN THE DYNAMIC MODEL Learn how to setup the unbiased and biased inferentials calculations to reproduce the same calculations performed in the AspenIQ modules and verify the accuracy of the implemented inferentials and their tuning parameters.	1.5 hours	Day 4
16	CONFIGURING AN ASPEN DMCPLUS CONTROLLER IN HYSYS: STEP-TESTING Learn how to use the DMCplus controller object within HYSYS to perform virtual step-test in the built column distillation model of the simulator. Export the formatted data for the MPC identification package.	1.5 hours	
17	IDENTIFICATION AND DEPLOYMENT OF THE ASPEN DMC3 CONTROLLER WITH HYSYS Import the data set generated in HYSYS and follow the basic Identification and Deployment workflow with Aspen DMC3 Builder. The connection is configured using HYSYS as an OPC Server and the controller is deployed from the DMC3 Builder application. This module will be shown by the instructor (no hands-on practice) as a review of a standard identification and deployment process and giving the instructions to link a DMC3 controller to a HYSYS Dynamic model.	2 hours	

*The time for each module is an estimation and can be adjusted/modified by the instructor during the training to fulfill all the contents to be learnt.

ADDITIONAL AVAILABLE RELATED MODULES

Some of these modules are still under development but are available under clients' request.

MODULE	MODULE TITLE AND SHORT DESCRIPTION	TIME	DAY
Option	USING RELATIVE GAIN ARRAY (RGA) TECHNIQUES How to use RGA analysis to determine the best input-output pairing combination in a distillation column.	3 hours	
Option	CONFIGURING ANTI-SURGE CONTROL FOR COMPRESSOR Learn how to configure an Anti-surge controller in a centrifugal compressor and test their performance.	2 hours	
Option	CONFIGURING A SMITH-PREDICTOR (OR SISO MPC) CONTROLLER Processes with large dead-times are poorly handled by standard PID controllers. They require more sophisticated controllers like a Smith-Predictor or a SISO MPC controller.	2 hours	
Option	CONFIGURING THE OPTIMIZER IN A STEADY-STATE CASE Learn how to use the internal SQP optimizer inside the steady-state simulator to conduct optimization studies for key control variables of the distillation column. Extract that data in a lookup table or regression to be implemented over the dynamic model.	3 hours	
Option	COMMUNICATION OF THE DYNAMIC MODEL WITH OPC Use the dynamic model with the OPC communication standard and link the model with an external controller developed in MATLAB.	3 hours	