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# Real-time dynamic process control loop identification, tuning and optimization software

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**Abstract**: In today's globally competitive marketplace, industrial plants are looking at new ways to increase plant efficiency, production rates, safety and reliability. Engineer education, training and plant optimization play a key role in satisfying technological, economical and environmental constraints. Furthermore, control system optimization is the basis for system improvement and advanced process control (APC) implementation.

Only a small minority of plants use modern software for controller tuning, simulation, APC or optimization. The reasons are absence of engineering knowledge, unavailability of practical and robust process control software tools for system identification, simulation and parameter optimization and running plants conservatively due to fear of causing shutdowns and plant problems.

This paper presents a process control simulator and loop optimizer applied to a temperature control application. This paper also illustrates the application of software for quick and easy multivariable closed-loop system identification using data from a plant's historian. Such software can tremendously help to improve control education of students and plant personnel.



*Keywords:* process control simulator, system identification, controller tuning, process control optimization education

## 1. INTRODUCTION

With relentlessly increasing pressures on profitability, survivability in a competitive global environment, premier oil-and-gas, chemical and other manufacturing companies are resorting to improved process control as one of the powerful methods to maximize their profits, minimize their utilities and remain competitive. Some of the established and accepted process control concepts include:

- Equipping all chemical plants with modern DCS (distributed control system) and PLCs (programmable logic controller), as described in Schuppen et al. 2011, Bolton, 2009, Cauffriez et al. 2004 and Rullán, 1997.

- Control primary process variables with PID (proportional, integral and derivative) controller.

- Apply multivariable and APC (advanced process control) strategies, as described in Guidorz *et al*. 2003.

The popular PID control algorithm performs over 95% of primary control in today's chemical and manufacturing industry. Despite being branded sometimes as "archaic" and "too-simple", the PID's existence provides simplicity, reliability and robustness, as described in Chen, 1989, Ljung, 1999, Reznik et al. 2000, Panda 2009 and Escobar et al. 2013.

Unfortunately, industry studies show that many plants continually suffer with less than optimal control performance of the primary control PIDs. Oscillatory ripples caused by inappropriate PID tuning, control valve problems and avoidable interactive disturbances continue to plague the primary control performance. Poor primary control performance can cost a plant anywhere from several hundred thousand dollars to several millions due to lost production capacity, poor product quality control and needlessly high utility usage. Furthermore, poor primary control performance will cripple higher level advanced control and optimization systems and severely reduce their potential monetary benefits.

Also, industry study shows that controller tuning, maintenance and control quality monitoring surprisingly remain grossly neglected and severely under-emphasized. In an era of modern high-tech tools, computers and engineering specialists, one can ask why the PID and primary control negligence is so commonplace. The reasons are many and diverse:

Poorly tuned controllers can still easily allow the plant to operate at nameplate or higher capacities. What is a missed opportunity is that an optimally tuned plant can make much more - as much as 2-7 % extra capacity.

While a failed instrument or a failed pump must be repaired to allow the plant to run, a badly tuned primary controller appears harmless - the oscillations and poor control response does not intuitively or obviously seem to be costing money or causing any harm. In reality, the impact on the overall plant


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performance because of a few poorly performing controllers can be shocking high.

College and university professors do an excellent job in covering academic primary process control concepts and controller tuning methods, but practical hands-on process control exposure is very hard to get. When new engineers and technicians come to the control room and start tuning control loops, their prior experience and skill level is rather low and they are often afraid of making tuning changes.

DCS-PLC technicians well trained on the basics of how the controller works have little opportunity for mastering tuning skills because of unavailability of simulators for tuning training practice.

The plant's operating performance can be impacted significantly and noticeably by the choice of tuning parameters. Control engineers and DCS-PLC technicians need to be formally trained on practical process control catering to the control room needs and environment. They should be provided with a real-time simulator on which they can practice tuning in a very real plant-like environment. They should have the freedom and ability on a control simulator to fearlessly drive loops unstable, study sluggish control, valve problems and the effect of external unmeasured disturbances on control quality.

Authorized persons bestowed with control room tuning privileges ought to be trained, qualified and certified based on testing on a simulator. Simulator-based training, practice time and then testing not only improves tuning skills but also helps the engineer or technician to identify control and instrumentation problems that earlier seemed too subtle and elusive. To address this current gap and facilitate training and certification of control engineers and technicians, new modern real-time dynamic simulator software (Simcet) and system identification, PID/APC tuning optimizer software Pitops have been developed.

## 2. PROCESS CONTROL SIMULATOR

Simcet is a real-time, online simulator for controller tuning practice and testing of tuning skills which provides the hands-on experience necessary to understand and tune control loops in the practical control room environment, Fig 1.

Typical examples, under the tuning practice window, which can be seen in Simcet are related to chemical, air separation, compressor, turbine, polyethylene, laboratory and other plants and processes. Under the new simulation in Simcet any other custom simulation can be also easily configured to mimic a specific plant or process by using typical scheme of desired process in the JPEG format, controller manual and Excel file containing controller PV and OP data.

The uniqueness of Simcet is that it also provides testing and grading features, under the tuning tests window, to test controller tuning skills of engineers and technicians. After playing and practicing with various pre-configured process simulations, the user can take up-to 36 randomly generated real-time tuning tests. Controller parameters optimised by the user are compared to the optimum controller parameters. A grade sheet is generated to show the user tuning skills. This report can be used as a certification and qualification record and to allow student, engineer or technician to be skilled enough for tuning real loops in the control room.

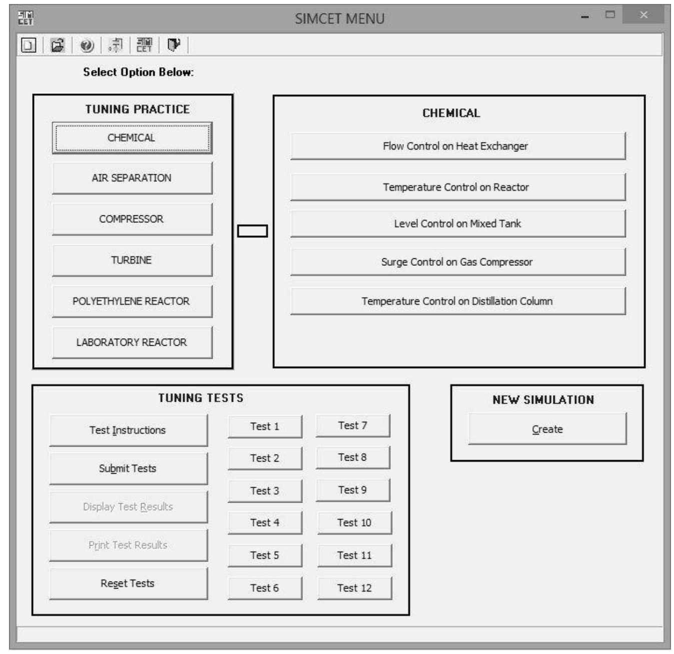


Fig. 1 Main Simcet tuning practice window

In each Simcet example the user can, Fig. 2:

See the process and process control scheme and highlighted process control trends showing process variable, setpoint and controller output movement in time domain.

Add typical signal noise and disturbances as in the real industry environment.

Change controller parameters and filter the noisy signal in order to improve the process control performance.

Switch the controller from manual to auto mode and vice versa and change the set-point or controller output.

Specify the controller algorithm and controlled and manipulated value range.

Activate the gap control.

Extend or reduce the simulation time and speed.

Collect and save the example data and changes in Excel for further analysis and trending.