Multivariable Identification and PID/APC Optimization for Real Plant Application

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The popular PID control algorithm performs over 95% of primary control in today's chemical and manufacturing industry. 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. Furthermore, poor primary control performance will cripple higher level APC (*Advanced Process Control*) and optimization systems and severely reduce their potential monetary benefits. Poor primary and advanced 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.

Nowadays, many valuable DCS (*Distributed Control System*) and PLC (*Programmable Logic Controller*) features are still underutilized. Often engineers, for plant PID tuning and APC optimization, use auto-tuning functions built inside of the dedicated control system or time-consuming trial-error and old fashion Ziegler Nichols tuning approaches which work well only on simple and fast PID loops. However, for slow or even complex and advanced loops mentioned approaches can generate uncertain or even wrong PID tuning parameters, so careful custom tuning is beneficial, reliable and much safer.

Only a minority of plants and chemical engineering faculties use modern software for controller tuning, simulation, APC or optimization. The reasons are absence of engineering and DCS-PLC technicians 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. Therefore, proper education, training and plant optimization play a key role in satisfying technological, economic and environmental constraints.

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, have the freedom and ability to fearlessly drive loops unstable, study sluggish control, valve problems and the effect of external unmeasured disturbances on control quality.

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 and presented.

Simcet is a real-time, online PID controller simulator for tuning practice and testing of tuning skills. It provides essential hands-on experience necessary to understand and tune control loops in the practical control room environment. Simcet allows tuning practice on variety of control loops which truly simulate the real plant control system. The other uniqueness of the software is in providing features for testing and grading engineer and student tuning skills.

Pitops is the acronym for Process Identification and controller Tuning and OPtimization Software. A unique and powerful feature of Pitops is time domain SISO (*Single-Input and Single-Output*) and MISO (*Multiple-Inputs and Single-Outputs*) closed-loop model identification from the past process data which can be oscillatory or even heavily impacted with disturbances. Pitops uses the NC-GRG (*Nonlinear Constrained General Reduced Gradient*) optimization. System identification is possible even on multiple chain PID cascade loops with model-based and/or feed-forward control loops.

This paper presents the application of software for quick and easy multivariable closed-loop system identification using real data from a plant's historian. The case study shows optimization of distillation column bottom temperature control which performance was significantly improved. For the column bottom temperature complete stabilization, except PID parameter tuning, the feedforward control was also designed producing a very stable and non-oscillatory response.