Enhance operational efficiency with Advanced Process Control (APC)

Integration of APC in SIMATIC PCS 7

SIMATIC PCS 7

Answers for industry.
In today’s competitive global marketplace, manufacturers in the process industry are being driven to continuously optimize their production processes. In view of this, calls for innovative strategies for improving the efficiency of process control, and therefore optimizing plant operations are becoming louder and louder.

Advanced Process Control

Closed-loop regulatory control in the process industry is based largely on the use of PID (Proportional-Integral-Derivative) control. It is well understood, easy to implement, and easy to integrate into the process control system, but soon reaches its limits in a plant with complex process dynamics. Advanced Process Control (APC) opens up new possibilities for optimizing these complex processes.

With APC, even the most complex relationships between process parameters and variables can be described mathematically and used to promote process optimization. APC enables more efficient operation of a plant by significantly reducing the consumption of energy and raw materials, optimizing product yield and quality, and by contributing toward more flexible production.

The key to unlocking increased efficiency

Until now, APC has had a reputation for being expensive and complicated to implement and maintain. With the innovative process control system, SIMATIC PCS 7, this is not necessarily so – even demanding APC applications can be implemented easily and cost-effectively. Depending on the problem or objective, different APC methods are optimum. SIMATIC PCS 7 includes a standard library containing a wide range of different types of APC control functions, making it possible to address the majority of complex closed-loop control tasks in the process industry. This provides the user with easy access to this advanced functionality at no extra cost. APC modules are supported via standard customer support channels and are included in the standard product lifecycle management process.

We also offer additional APC functions as optional add-ons to a PCS 7 system. These add-ons are designed and tested to ensure flawless operation and seamless integration with PCS 7.
Simple and economical

With PCS 7’s comprehensive suite of APC functionality, numerous benefits can be delivered. The investment costs and personnel resources typically required for implementation of APC are minimized – APC functions can be configured easily and without external support – for a number of applications. These include: the closed-loop control of reactors, distillation columns and coupled systems; and the open-loop control of grade-change, load-change and product-change processes. In all cases, the robust APC functionality provided with PCS 7 can be used to considerable advantage: Undesirable variations in critical process variables and other critical-to-quality parameters can be reduced drastically and the consumption of raw materials and energy can be minimized. The tight integration of APC functionality into PCS 7 helps minimize operator training and improve efficiency. Customers also can achieve significant increases in product throughput, yield and quality.

Ready to use immediately

A real highlight of the APC functionality integrated into SIMATIC PCS 7 is how easy it is to begin using. In fact the Control Performance Monitoring functionality helps you identify which loops are the worst performers, so that you know where to begin. An APC control module template is then selected from the library based on the type of closed-loop control problem, and the parameters are configured and loaded. The standard APC control modules can be modified easily facilitating the creation of custom modules which meet project-specific requirements.
As a long-term supplier to the process industry, Siemens can also help you to increase the efficiency of your plant cost-effectively. We offer a wide variety of comprehensive, pre-engineered control modules in the standard library of SIMATIC PCS 7. We also support a wide range of optional APC add-on modules, which can be purchased separately. In contrast to third-party suppliers whose APC methods are linked to the process control system via interfaces, these add-ons consist of function blocks and HMI elements which can be integrated seamlessly into SIMATIC PCS 7.

... available at no extra charge in the standard library of SIMATIC PCS 7

In addition to the large number of standard pre-engineered control modules, for example, monitoring measured values or controlling on-off valves or motors, the standard library also contains control modules (templates) for basic analog control functions, such as:

- PID control
- Cascade loop control
- Split-range control
- Ratio control

The standard library also contains a variety of APC control modules provided at no extra cost. APC functionality consists of PCS 7 function blocks, which run in the controller, along with pre-built faceplates for operation and monitoring through the HMI.

- Control performance monitoring
- Gain scheduling
- Butterworth low pass filter
- Override control
- Lead-lag / Feed-forward
- PID tuning
- Smith predictor
- Model-based predictive control

... seamlessly integrated into SIMATIC PCS 7 as an add-on product

- Fuzzy control
- Soft sensor/Neural Networks
- Operator training simulator
Gain scheduling

- Suitable for non-linear processes
- 3 complete parameter records are available for 3 operating points
- Application examples:
  - pH control (neutralization) with non-linear titration curve
  - Temperature control of boilers
  - Batch processes with chemical reactions (non-linear response kinetics)

Override control

- Two (or more) PID controls share a common final control element
- Access to the final control element is determined based on the status of the process
- Application examples:
  - Primary process variable: Flow control
  - Secondary process variable: Pressure limiting (for safety)

Lead-lag/feed-forward control

- Used to compensate for measurable, large disturbances which directly affect the operation of the control loop
- Compensation takes effect before the disturbance can have a negative effect on the process
- Pre-engineered template (CFC) based on standard function blocks
- Application examples:
  - Temperature control of an industrial furnace (disturbance variable: flow)
  - Boiler reactor flow balance based on feed composition (disturbance variable: concentration of inflow)

PID tuning

- Optimize the control tuning of standard PID control loops
- Applicable to standard PCS 7 PID control modules and also to user-created custom function blocks
- Simulation of closed control loops
- Application example:
  - Optimization of the control parameters of PID controls (in any applications)
Control performance monitoring

- Online monitoring of the control loop's performance
- Identification of control loops in a plant:
  - Which are not performing optimally (the first step before implementing APC)
  - In which faults are developing
- Configurable alarm limits help to identify issues with deviation and overshoot allowing you to perform preventative maintenance and determine the cause of faults
- Visualization using faceplates and status symbols within the HMI
- Application example:
  - Large-scale plants with many control loops, e.g. refineries

Smith predictor

- For processes with long dead times that are known and (usually) constant. Utilizes the “Internal Model Control” principle of model-based control
  - The process model runs in parallel with the real process
  - An estimate of the process variable affected by dead time is made in the model and is fed into the PID control module
  - Deviations from the model output and actual measured value are also fed back and taken into account
- PI(D) control design
  - Based on the dead time-free part of the process model
  - Supplies much more accurate control settings
- Application examples:
  - Polymerization
  - Closed-loop control of analysis values (based on the analysis dead time)

Model-based predictive control (MPC)

- The most powerful APC function
- Scalable MPC applications
  - Up to 4 x 4: internal (“lean”) MPC
  - More than 4 x 4: external “full-blown” MPC
- “Lean” and “easy to use”, function blocks reside in the controller which means there is no need for communication monitoring nor back-up strategies
- Application examples:
  - 2 x 2 applications: Two component distillation, paper manufacturing, dual-tank system
  - 3 x 2 applications: Steel bleaching
  - 3 x 3 applications: Continuous reactor, evaporator, distillation column
  - 3 x 4 applications: Cement mill
  - 4 x 4 applications: Three component distillation, LPG evaporator, multi-burner furnace
Practical example: Configuring MPC in four easy steps

The advantages of PCS 7’s APC implementation are best illustrated on the basis of an example – in this case, the Model-based predictive controller (MPC): The lean multi-variable MPC processes up to four controlled and manipulated variables as well as one disturbance variable in a standard function block. This control can be completely configured in just four steps:

**Step 1: Implement function block**
Implementation is easy with Drag & Drop: In SIMATIC Manager, the central project management system, drag the MPC block out of the library onto a CFC chart and connect it – SIMATIC PCS 7 will automatically generate the corresponding HMI faceplate, complete with alarms.

**Step 2: Perform a step test**
With a step test, the MPC modeling tool will automatically learn the dynamics of the plant: A unit change is applied to a setpoint.

By disturbing the process, the response, which is presented in the trend display, can be analyzed mathematically in order to create the model.

**Step 3: Modeling with just a few clicks**
Only a few actions are required to create the model’s relationship between the controlled and manipulated variables. The parameters are weighted to configure the MPC as “aggressive” or “conservative.”

**Step 4: Compile and load into the running system**
The function block containing the model can be compiled at the click of a button, then loaded into the CPU and tested. The operator now has a robust, model-based predictive control that can be operated seamlessly alongside traditional PID control.
Further information on our portfolio on the Internet:

www.siemens.com/simatic-pcs7