aspenONE® Advanced Process Control

Breakthrough flexibility and ease of use for building, deploying, and managing APC applications.

The process industries encompass an incredible range of products, processes, and plant configurations. A range of APC solutions are needed to address such a diverse set of production processes. aspenONE Advanced Process Control provides two approaches for advanced control applications: the industry-leading *Aspen DMCplus*® controller and the new Aspen Control Platform.

Aspen DMCplus: The Process Industry's Workhorse Multivariable Controller

Aspen DMCplus is the industry-leading, multivariable model-predictive controller proven for maintaining processes at their optimal operating point. It interfaces to processes directly with the DCS or indirectly through process information management systems, capable of safely pushing processes to multiple constraints simultaneously. Aspen DMCplus efficiently scales to the largest control problem size and has been successfully applied to virtually every linear control problem in refining, chemicals, and petrochemicals processing. Aspen DMCplus is a core component of aspenONE Advanced Process Control.

Aspen DMCplus combines an integrated set of desktop tools for controller analysis and design with an online system for controller deployment.

Key Benefits

- Maintains optimum quality across a range of products and operating conditions
- Provides excellent disturbance rejection resulting in lower process variability
- Maintains tight control and reduces process variance across the entire operating range
- Maximizes throughput by operating closer to constraints
- Improves plant safety by compensating for process disturbances
- Lowers cost of ownership

Aspen DMCplus Desktop

Aspen DMCplus Desktop is comprised of an integrated suite of three programs:

- **DMCplus Model** offers multiple model identification algorithms plus model prediction, model uncertainty, and cross-correlation features for model analysis.
- **DMCplus Build** makes controller configuration and maintenance easier with detailed, context-sensitive help and an automatic configuration validation wizard.
- **DMCplus Simulate** enables interactive evaluation and testing of controller performance in the face of model mismatch and process measurement noise.

Aspen DMCplus Online

Aspen DMCplus Online consists of two standard layers and an optional third layer:

- **DMCplus Control** is the online controller program and performs input validation, steady state target calculation, and dynamic move calculations.
- **DMCplus Connect** links the DMCplus controller with the process unit.
- **DMCplus Composite** is an optional program to allow a mix of slow/fast dynamics and larger scale solutions.

Aspen Control Platform: A New Level of Flexibility, Efficiency, and Ease-of-Use

Aspen Control Platform is a new environment that provides unmatched technical and commercial scalability, extending the benefits of APC to smaller and less complex units. It delivers unrivaled benefits by integrating all of the tools and features required for building, testing, deploying and managing APC applications into one centralized platform. The results are improved quality, reduced energy consumption, increased throughput, higher yields of products, and a lower cost of ownership.

With the Aspen Control Platform you can build, deploy, and manage APC solutions for a broad range of processes—from simple linear to non-linear. The Aspen Control Platform is unique in that it provides three control model types in a single package. Along with choices in control formulations, Aspen Control Platform can be integrated with a complete set of features for loop and controller monitoring, process and product performance management, and sustained value. These features help you deliver consistent benefits without a high maintenance burden.

Greater Flexibility and Rapid Deployment

Aspen Control Platform provides the ability to build, connect, deploy, and manage APC applications from a single integrated environment. The built-in workflow guides you through the process of building, testing, and deploying controllers and related applications. You can manage your servers, applications, and data collection with one program.

- Deploy applications from your development environment
- Track changes during re-deployment
- Get controller and history snapshots directly into your workspace
- Easily convert from one control formulation to another
- Predict, control, sequence, and optimize models
- Connect models to various data sources
- Monitor and track changes during deployment

Key Features

- Integrated data collection, viewing, conditioning, slicing, and transforms
- Integrated model viewing, merging, convolution, and transforms
- Integrated sub-space model identification
- Integrated controller configuration and tuning
- Integrated simulation running against either a model or historical data
- Integrated tag browser
- Tag templates to simplify configuring plant IO connections
- Real-time online server
- And more

"To be able to do multiple types of controllers in the same software platform is quite amazing."

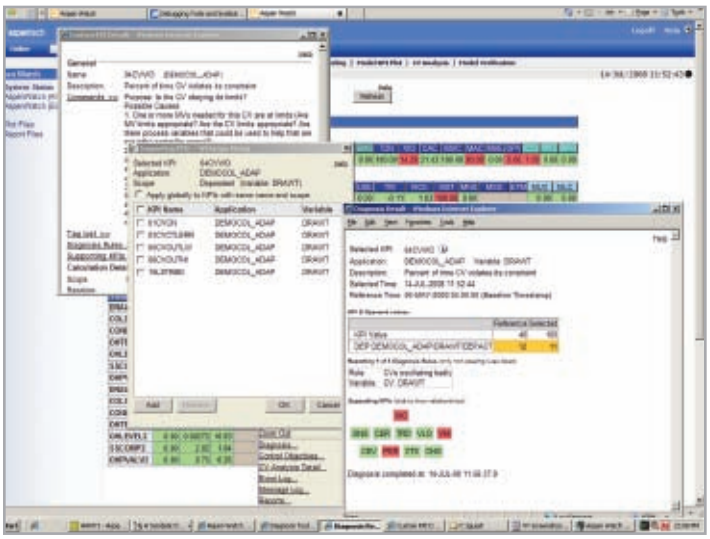
— Francois Toutain, APC Department, Arkema (France)

The AspenTech® Solution: A Single, Flexible Platform Delivers Sustained Value

aspenONE Advanced Process Control provides a unified environment for AspenTech's three industry-leading control formulations within an architecture that provides the ultimate flexibility and usability. The choice of three control formulations provides superior control performance, execution efficiency and exceptional constraint handling to maximize asset utilization regardless of the control challenges. Major benefits are realized through reduced variability, increased throughput and increased yields of more valuable products.

Sustainability

Many APC solutions suffer from degrading benefits. Process changes, equipment aging and changing economic conditions are but a few of the factors that drive the need to maintain controller models. While many competitors offer basic performance monitoring capabilities, *aspenONE Advanced Process Control* goes beyond simple Key Performance Indicators (KPIs) by providing detection, diagnostics and corrective action features. These features work together to rapidly detect, isolate and correct problems with APC applications without increasing the burden on your staff.

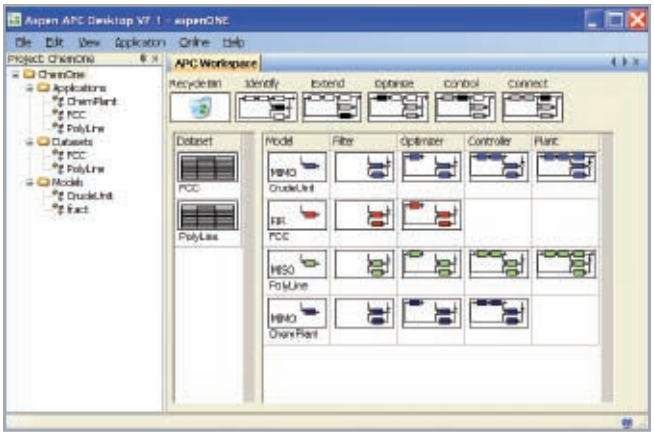


The Sustainability features of aspenONE help to quickly identify diagnose and correct problems with eroding performance.

Control Models

aspenONE Advanced Process Control provides three different controller formulations in a single package.

- The industry-leading Aspen DMCplus® formulation based on the FIR model form (finite impulse response)
- Linear MIMO State Space (multiple input – multiple output)
- Nonlinear MISO State Space (multiple input – single output)



aspenONE APC delivers multiple control formulations in a single package. These formulations share a common workflow for rapid development and consistent implementation.

Switching between formulations is accomplished with a simple mouse click. Older versions of Aspen Nonlinear Controller and Aspen DMCplus controllers are easily imported with automatic model, script and tuning conversion.

The modeling tools are implemented in a modern (.NET) drag-and-drop environment for model building, simulation, configuration and deployment. The entire control application can be built, simulated and deployed within *aspenONE Advanced Process Control*, providing a true competitive advantage with a seamless interchange between the three industry-leading control formulations.

Formulation	Prediction	Filter	Optimizer	Controller
FIR (Aspen DMCplus)	FIR models. Current CV predictions are kept in memory and current moves are added to it.	Bias is added to each output. First order time constant can be used to filter the update. Rotation factor used for ramps.	Upper and lower ranked limits for CVs (linear or quadratic type). Ranked ETs can be specified on inputs and outputs. Costs on inputs and outputs. Algorithm is a revised simplex method for LPs. Interior point for QPs. Interior point can also be used for LPs.	Number of moves from 8 to 64 is specified. Matrix inversion is used to create an analytical solution to the unconstrained problem. "Clipping" of the inputs is used to enforce constraints. Option to use QP solution. Also, option added to treat CV constraints more rigorously. Problem solution time is cubic in number of MV and number of moves.
State Space MISO	MISO models. State of the linear part of each model is maintained and updated each cycle.	Bias is added to each output. Noise ratio can be used to filter. Internal states are not updated (except through prediction). Rotation factor used for ramps.	Upper and lower ranked limits for CVs (linear or quadratic type). Ranked targets can be specified on inputs and outputs (target can be an ET or upper or lower limit or minimum move). Costs on inputs and outputs. Algorithm is an SQP. Each QP iteration uses the interior point method. Trust regions are used to expand the search region. This usually takes 11 QP iterations.	Number of moves for each MV is specified. Algorithm is an SQP. Each QP sub-problem is solved with an active set method. A line search is used to expand the search region. This usually takes 2 to 6 QP iterations. Problem solution time is cubic in number of MVs and number of moves. Dependence on number of states is not known but probably small (and models usually low order).
State Space MIMO	MIMO models. State of the model is maintained and updated each cycle.	Internal states are updated using a Kalman filter. Typical noise and disturbance used for tuning. Input and "internal" disturbances can be specified.	Upper and lower ranked limits for CVs (only quadratic). Ranked ETs can be specified on inputs and outputs. Costs on inputs and outputs. Algorithm is an interior point method.	Number of moves is specified (no limit). Algorithm is an interior point method—extensively customized to take advantage of the problem structure. Problem solution time is cubic in number of MVs, quadratic in number of states, and linear in the number of moves.

Prediction & Inferential Measurements

aspenONE Advanced Process Control provides a powerful package for modeling of inferred product qualities. Inferentials are a supplement for infrequently measured qualities or critical sensors, and are also used to support environmental compliance. *aspenONE Advanced Process Control* provides a rich choice of model types, making it possible to implement linear or nonlinear inferential sensors online. Flexible analyzer and laboratory modules automatically adjust the inferred qualities to ensure accuracy.

Benefits

- Validate instrumentation and provide early detection of drift or malfunction
- Augment or replace physical instrumentation for process measurements
- Improve control by providing feedback between lab samples
- Reduce lab costs
- Improve models via software-assisted variable selection

Inferential model types include FIR, PLS, fuzzy PLS, hybrid neural net, monotonic neural net, linearized rigorous model-based, and custom equations.

Key Capabilities

- Built-in steady-state detector
- Can be used stand-alone or integrated with Aspen DMCplus and Aspen InfoPlus.21®
- Provides both analyzer and lab model updating
- Wide range of DCS and information system interfaces available
- Enabled for remote monitoring
- No code generation or programming required

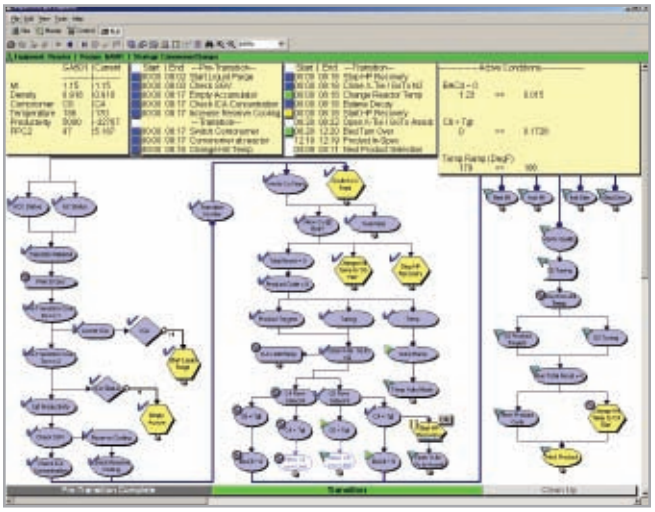
Sequence Control

Sequence Control is a feature that integrates Aspen Process Recipe and the Aspen InfoPlus.21 real-time database to deliver recipe information to process control systems, operators and other applications that depend on grade-specific data. The Sequence Control Manager enables users to create and implement complex recipe transition strategies. These strategies permit multi-step transitions based on sophisticated rules and logic that are implemented through an advanced calculation tool. At the time of transition, an operator selects the product, invoking the appropriate recipe and transition strategy, and initiates transition execution via Sequence Control.

Key Capabilities

Sequence Control offers manufacturers the opportunity to significantly reduce their transition times and off-spec material losses. This is especially true for processes that need to manually or automatically:

- Coordinate operator actions with the process automation system
- Manage sequence events
- Execute recipe items in a specific order
- Manage multiple grades
- Manage various steady-state conditions



The Sequence Control features of aspenONE integrate operator actions with the control application. Operators can view the task list and see progress indicators for each task.

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Simulation

aspenONE Advanced Process Control enables the use of on-line simulation based on rigorous models. Typical applications include improving controller models, generating shadow targets for operators, providing what-if simulations to aid operators and engineers in identifying and resolving process problems, and generating KPIs for real-time performance management. *aspenONE Advanced Process Control* provides the ability to incorporate models from a wide range of AspenTech products.

Key Capabilities:

- Execute process models using real-time process data
- Provide data validation, data conditioning, and steady state detection
- Execute on a repeated, fixed-period schedule
- Autonomously detect, accommodate, and recover from data quality, network / system, and solver problems
- Compatible with Aspen Simulation Workbook™

Design / Analysis of Control Schemes

- Design the process and control system simultaneously
- Analyze and improve basic control strategies (e.g., fractionators, compressor surge, location of sensors, etc.)
- Pre-tune control loops
- Evaluate, develop, and test APC scenarios

Operability Engineering Studies

- Understand dynamic plant behavior, including upset propagation
- Operability studies of highly-integrated processes
- Design / analysis of start-up, shutdown, and process transition strategies and procedures

Hazard & Safety Studies

- Design / analysis of pressure relief and flare systems
- Safety studies
- Design / analysis of emergency shutdown systems with Cause & Effect Matrix

Operator Training

- Emergency / Upset scenarios
- Accumulate knowledge
- DCS checkout
- Graphics functionality/operability of the operator consoles

Sustained Value

Advanced model-predictive control systems are now deployed in thousands of applications worldwide, delivering large financial benefits. However, the performance of controllers can degrade over time if they are not modified as plant equipment and operating conditions change. Maintaining APC applications at peak performance requires three activities working in concert:

Detection

aspenONE Advanced Process Control provides a full set of features for monitoring control applications, PID loops, and production assets. The three controller configurations are supported with preconfigured sets of KPIs that provide out-of-the-box controller performance monitoring. These KPIs are automatically pre-configured when you create a controller in the Aspen Control Platform. Users can add KPI definitions to provide additional insight into process performance and product quality. KPIs are supported with built-in calculation scripting features, greatly simplifying the task of creating and managing operational KPIs.

Diagnostics

The most common cause of APC performance degradation occurs when the controller model no longer matches the actual plant performance. This mismatch occurs as plant equipment wears or as process improvements are made. The standard KPIs for models help to quickly determine the source of model mismatch — including the ability to identify specific MV/CV pairs within the model that are at the root of performance degradation.

Corrective Action

Achieving maximum benefits from APC applications requires high service factors. When controllers do require revamps, AspenTech's sustainability features help to quickly collect new process data, clean that data in preparation for building new models, and provide automation to quickly iterate through candidate models.

Automating Best Practices in Process Unit Step Testing

AspenTech's automated testing features simplify and streamline the task of collecting process data for model construction. Delivered model data has higher information content than manual testing while reducing the overall engineering effort.

Key Capabilites

- Controller to enforce MV limits while keeping CVs within bounds
  - Generates a constrained step test (e.g., valve limits, column qualities are honored)
  - Larger steps are possible
- Operating point for step testing can be defined and modified by operations
- Allows any MV to be paired with another MV
  - Both are stepped in a given ratio in order to obtain more informative test data
  - Data allows identification algorithms to determine gain ratios and RGA numbers of nearly co-linear sub-matrices
- Specify preferred first step direction for test moves

Adaptive Modeling

Aspen Adaptive Modeling automates the maintenance lifecycle of a controller by providing the ability to collect historical data, automate calculations for data cleaning, schedule online model quality assessments, and assess model quality, model diagnostics and online model identification for standard and custom KPIs.

Key Capabilities

- Integration with AspenWatch Performance Monitor for historical data collection
- Ability to customize calculations for automated data cleaning
- On-demand or automated model quality assessments
  - Assessment of model gain accuracy
  - Library of model assessment KPIs
- Carpet plots for viewing model performance KPIs
- Model diagnostic tools
- On-demand or automated online model identification
  - Subspace model identification
  - Online (PCWS-based) comparisons of model ID cases
  - Easy export of new models into updated controller

aspenONE APC provides a full set of integrated features for developing, deploying, and maintaining advanced control applications.

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aspenONE Advanced Process Control enables companies to increase throughput, improve product quality, reduce energy and raw material usage, and increase overall operational efficiency while keeping the process between safe limits of reliable operation. Additional benefits include standardization of processes and consistent use of best practices, ensuring higher operational stability and reduced maintenance requirements, therefore sustaining long-term value.

About AspenTech

AspenTech is a leading supplier of software that optimizes process manufacturing—including oil and gas, petroleum, chemicals, pharmaceuticals and other industries that manufacture and produce products from a chemical process. With integrated aspenONE solutions, process manufacturers can implement best practices for optimizing their engineering, manufacturing and supply chain operations. As a result, AspenTech customers are better able to increase capacity, improve margins, reduce costs and become more energy efficient. To see how the world's leading process manufacturers rely on AspenTech to achieve their operational excellence goals, visit **www.aspentech.com**.

Worldwide Headquarters

Aspen Technology, Inc.
200 Wheeler Road
Burlington, MA 01803

phone: +1-781-221-6400
fax: +1-781-221-6410
info@aspentech.com

EMEA Headquarters

AspenTech Ltd.
C1, Reading Int'l Business Park
Basingstoke Road
Reading, Berkshire
RG2 6DT United Kingdom

phone: +44-(0)-1189-226400
fax: +44-(0)-1189-226401
ATE_info@aspentech.com

APAC Headquarters

AspenTech (Shanghai) Co., Ltd.
3rd Floor, North Wing
Zhe Da Wang Xin Building
2966 Jin Ke Road
Zhangjiang High-Tech Zone
Pudong, Shanghai
201203, China

phone: +86-21-5137-5000
fax: +86-21-5137-5100
apac_marketing@aspentech.com