SmartProcess® Distillation

Maximize performance of your distillation columns by using advanced process control (APC) technology.

- Reduce product quality variation and off-spec production

- Minimize quality giveaways

- Minimize energy consumption per unit of feed

- Increase recovery of more valuable products

- Maximize feed rate upon demand

- Increase column throughput

- Lower costs of implementation

Introduction

Distillation column are classic examples of highly interactive, multivariable processes that exhibit long delays and lag times - challenging conditions for conventional PID regulatory controllers.

Operating objectives for columns may include controlling both overhead and bottoms product purities, minimizing energy, and maximizing throughput while maintaining operations within equipment limits.

Emerson Process Management delivers SmartProcess®, a pre-engineered, modular solution for model predictive control (MPC) of distillation columns using DeltaV's embedded advanced process control (APC) technologies. The solution includes software and services to implement MPC and neural modules for control of any 2 or 3-product distillation column.

Benefits

Anything that changes, whether it is the feed rate, feed composition, or even the weather can have an impact upon distillation column operation, so operators tend to avoid going off-spec by using more energy than is necessary. Product over purification is expensive both in energy and product yield. *Emerson's SmartProcess® Distillation automatically compensates for common disturbances like feedstock and weather to maintain product compositions on-spec while simultaneously improving energy efficiency.*

The more pure the product, the more energy is wasted by over-purification, making high-purity columns prime targets for energy savings. Advanced Process Control *reduces the column variability, pushes to minimum reflux limits and allows operators to run closer to the specifications.* This in turn results in improved product quality controls, less quality giveaway, lower specific energy consumption and fewer emissions.

SmartProcess® Distillation can optimize energy usage against the value of the products recovered to automatically adjust to changes in energy cost or product demand. Recovery is optimized as the unit responds to changing feed rate, composition and shifting plant constraints. Online composition analysis and best-in-class measurement capabilities enable more consistent operations and faster, more stable responses to disturbances.

When maximum capacity is called for, SmartProcess® Distillation can continuously operate a distillation train at the most limiting overall constraint. This means that *column throughput will automatically be adjusted for conditions such as ambient temperatures or feed quality that can affect equipment limits, thus increasing the average capacity of the overall distillation unit.*

Using the expertise of our consultants engaged in many APC projects around the world, Emerson has developed an extensive library of SmartProcess® Advanced Control applications that can be reused and configured for a specific project. This library drives down the cost of implementing and maintaining advanced control applications by providing standard, tested and supported DeltaV libraries for projects around the world.
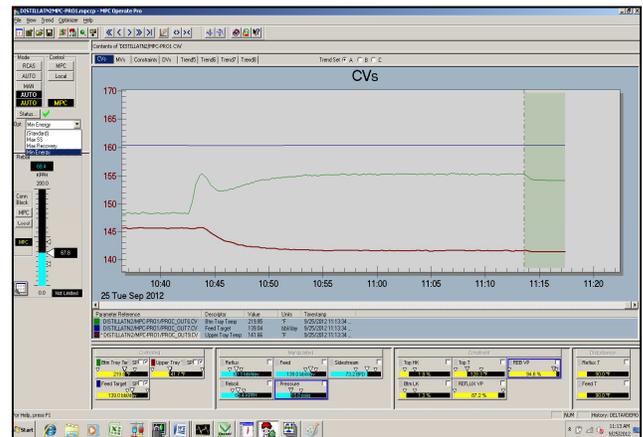
Product Description

Emerson's Smart Process Distillation application is designed for a DeltaV digital automation system, working with smart field devices to improve product quality, recovery and energy efficiency. The DeltaV embedded APC tools provide a platform to control and optimize the distillation process using an embedded linear program. The solution provides closed-loop product quality control using a real-time, multivariable controller that calculates optimal control moves for safe, stable operation.

Advanced control applications supplied with the SmartProcess® Distillation application, include a combination of advanced regulatory control functions, custom calculations and embedded DeltaV APC technologies such as Model Predictive Control (MPC) and Neural Net inferential modeling.
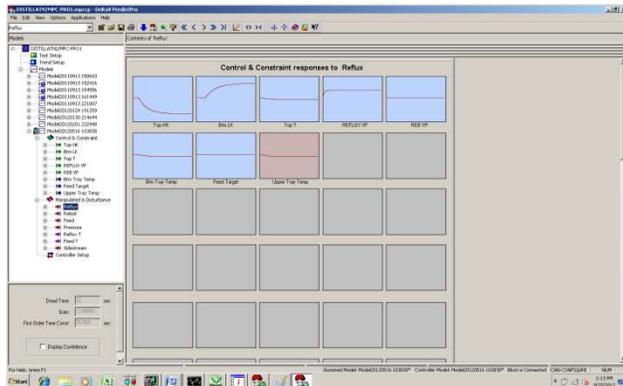
DeltaV PredictPro - Model Predictive Control

Model Predictive Control (MPC) is a technique to provide improved control of multivariable process units. *MPC uses dynamic models of the process, and a record of its past behavior, to predict how the process will behave in the future.* These predictions are then used to determine an optimum sequence of control actions that ensure all process control objectives are achieved simultaneously. The process models are obtained from unit testing and are adjusted online using plant measurements to ensure future predictions and actions are always consistent with desired process operation.

MPC is ideal for controlling distillation columns, where there is more than one interacting controlled variable, long time constants and multiple equipment limits and operating constraints that must be observed. With MPC, future constraint violations are predicted such that adjustments can be made in advance to prevent critical limits from being violated. Priorities are used to achieve the desired controller behavior when one or more constraints must be violated, allowing the most critical controlled variables or constraints to always be maintained.

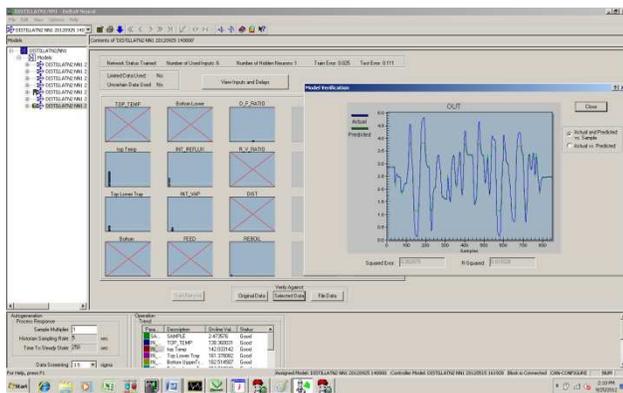*DeltaV PredictPro Operator display trends history as well as future predictions.*

Embedded DeltaV PredictPro tools use dynamic process models to predict future behavior.

Emerson's DeltaV Predict/PredictPro represents a new generation of Model Predictive Control solutions, completely embedded in the control system. Its ease-of-use is unmatched in the industry. SmartProcess® Distillation includes the required PredictPro licenses needed to control a typical column.

DeltaV Neural - Inferential Modeling

Distillation processes usually exhibit long response times for product compositions to react to changes in variables like feed rate, reboiler duty, distillate rate, and reflux rate. Laboratory samples are only performed a few times a day. On-line analyzers provide results many times per hour, but may not be installed as part of an automation project. In the absence of frequent product analysis, various inferential techniques can be used to predict the real-time product quality values used for control purposes. One such technique uses the embedded DeltaV Neural application to predict real-time quality values

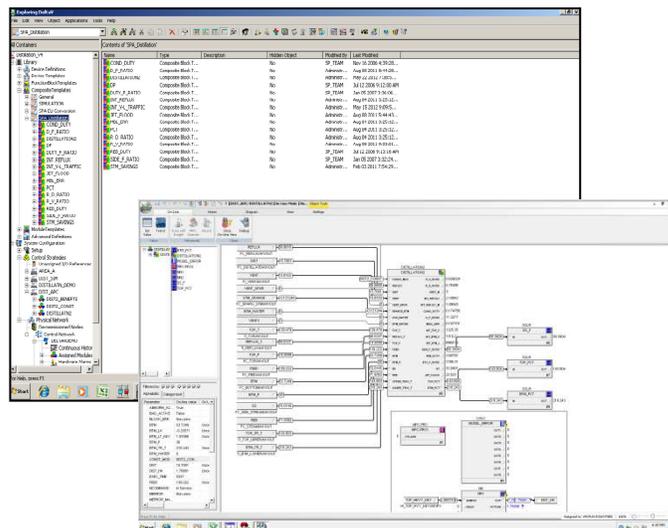*Easily Create Product Quality Predictions with DeltaV Neural*

DeltaV Neural can be easily applied to automatically create non-linear process models using historical data. Once placed on-line the predictions from DeltaV Neural modules can be used for operator guidance or as part of an advanced control application. These predictions are updated periodically from either laboratory samples or on-line analyzers.

The SmartProcess® Distillation license includes the necessary DeltaV Neural modules needed for quality models of two products.

SmartProcess® Distillation Library

The SmartProcess® Distillation Library includes the following components:

- DeltaV Module libraries, templates and composites
- Standard distillation calculation blocks:
    - Internal Reflux
    - Column Vapor
    - Liquid Traffic
    - Jet Flooding
    - Reboiler and condenser duty
    - Pressure compensated temperature
    - Engineering Unit Conversions
    - Energy Savings
- Example SmartProcess® Distillation configuration with simulation and graphic
- Documentation: Installation and Configuration Guides, Sample Functional Design Spec

Standard DeltaV Libraries Make Configuration Easy

Certified Consultant Engineering Services

Emerson's Certified Solutions Consultants provide standard engineering services to design, configure, install and commission a complete SmartProcess® solution. The scope can cover individual distillation columns or complete fractionation trains. At the start of a project, our consultants will review the process, operating objectives, constraints and economics to design the APC strategy, benchmark current performance and develop a project execution plan.

A standard methodology is used for implementing SmartProcess® applications as follows:

- Kickoff meeting and site survey
- Regulatory Control Performance Audit
- Preliminary step tests and column step test design
- Distillation column step tests and model identification
- Controller simulation and testing
- Operator Training
- Commissioning and tuning.

Most of these activities are done on-site using the actual plant DeltaV system and tools. For a single distillation column, with good performing regulatory controls, the SmartProcess® application can be implemented in about 2 to 3 weeks from kickoff meeting to on-line operation.

Optional Engineering Services

Emerson, through our field services offices and Local Business Partners offer a full range of services to assist our customers with their automation systems. Customers have the option of performing some of the work internally or requesting support from Emerson. Some examples of optional services which are often included as part of a SmartProcess® implementation project include:

- Graphics Development: Custom APC operator screens or displays, modifications to existing displays.
- P&ID Review and Control Strategy Recommendations: In some situations, Emerson's consultants can review P&ID's prior to construction and recommend modifications to the regulatory control strategies for improved performance.

- New Instrumentation or Analyzers: At times, a SmartProcess® application will justify installing additional instrumentation or on-line analyzers.
- Regulatory Control Improvement: As part of the SmartProcess® implementation process, Emerson's consultant will identify any malfunctioning or poorly performing instrumentation, valves and control loops. However, engineering services to analyze the issue, troubleshoot and correct the problems are additional.

DeltaV Hardware and Software

SmartProcess® Distillation applications are standard DeltaV modules that can be implemented in either a controller or an application station. The additional load these APC modules place on a DeltaV system is expected to be nominal, since the execution frequency for the APC functions is typically much slower than the regulatory controls and can therefore be implemented on the existing platform without any additional hardware investment. For more heavily loaded systems, Emerson can advise of recommended changes.

Licenses for the DeltaV APC tools (PredictPro and Neural) are bundled with the SmartProcess® Application Library modules as described below.

SmartProcess® Distillation License

SmartProcess® Distillation is licensed on a per-column basis. On installation of the software, a standard "click-wrap" license agreement stipulates the terms of the license and restricts use to the specific columns for which it was licensed.

Licenses for the DeltaV APC tools are bundled with the SmartProcess® application and include the following embedded products:

- DeltaV PredictPro – Up to 4 MV's per column
- DeltaV Neural – Up to 2 Neural modules per column

System Compatibility

SmartProcess® Distillation applications are available on DeltaV v11.3 and higher systems.

Ordering Information

Description	Model Number
SmartProcess® Distillation for One Column; Includes 1 Base License, 4 DeltaV PredictPro Output (MV) licenses, 2 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines	VF1040B1C1
SmartProcess® Distillation for Two Columns; Includes 1 Base License, 1 Extension License, 8 DeltaV PredictPro Output (MV) licenses, 4 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C2
SmartProcess® Distillation for Three Columns; Includes 1 Base License, 2 Extension Licenses, 12 DeltaV PredictPro Output (MV) licenses, 6 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C3
SmartProcess® Distillation for Four Columns; Includes 1 Base License, 3 Extension Licenses, 16 DeltaV PredictPro Output (MV) licenses, 8 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C4
SmartProcess® Distillation for Five Columns; Includes 1 Base License, 4 Extension Licenses, 20 DeltaV PredictPro Output (MV) licenses, 10 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C5
SmartProcess® Distillation for Six Columns; Includes 1 Base License, 5 Extension Licenses, 24 DeltaV PredictPro Output (MV) licenses, 12 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C6
SmartProcess® Distillation for Seven Columns; Includes 1 Base License, 6 Extension Licenses, 28 DeltaV PredictPro Output (MV) licenses, 14 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C7
SmartProcess® Distillation for Eight Columns; Includes 1 Base License, 7 Extension Licenses, 32 DeltaV PredictPro Output (MV) licenses, 16 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C8
SmartProcess® Distillation for Nine Columns; Includes 1 Base License, 8 Extension Licenses, 36 DeltaV PredictPro Output (MV) licenses, 18 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C9
SmartProcess® Distillation for Ten Columns; Includes 1 Base License, 9 Extension Licenses, 40 DeltaV PredictPro Output (MV) licenses, 20 DeltaV Neural licenses, SmartProcess® Distillation Library, and Configuration Guidelines.	VF1040B1C10
SmartProcess® Distillation License - Extension License for additional Column(s). (Includes 4 DeltaV PredictPro Output (MV) licenses, 2 DeltaV Neural licenses for each quantity ordered)	VF1040E1
Annual SmartProcess® Distillation Application Support – Base License	VF1040S1
Annual SmartProcess® Distillation Application Support – Extension License	VF1040S2

Related Products

■ **Control Performance Consulting Studies:** It is a well-proven fact that performance of the regulatory control sysem, from sensor to valve, is critical for safe and reliable plant operations. Whether it is caused by malfunctioning control devices or poor loop tuning, Emerson's consultants have the experience and skills to identify, troubleshoot and correct any control-related issues.

■ **SmartProcess® Distillation Annual Support:** Guaranteed access to new versions, enhancements and updated documentation. With an Application Support agreement, you can rest assured that expert help is only a phone call away and your SmartProcess® Distillation will remain current with future system upgrades.

Prerequisites

■ DeltaV v11.3 or higher

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