

SmartProcess™ Compressor Solution by DeltaV™

- Eliminate black boxes
- Integrate with DeltaV™ or as a standalone PK Controller package
- Increase compressor operation range
- Minimize the risk of compressor surge
- Stabilize the main process parameter of the compressor
- Reduce energy consumption
- Balance the load of parallel compressors
- Faster startups
- Tune and configure all devices in the control loop from one place
- Lower cost of implementation



Maximize performance of your compressors by using compressor control technology.

Introduction

Centrifugal and axial compressors are aerodynamic devices that operate safely and efficiently only when being used in the process conditions for which they were designed.

When process conditions around the compressor change, compressors can become inefficient or even unstable. The high rotating speed and considerable energy transferred to the gas require precise measurements and fast and efficient control functions.

The aerodynamic nature of compressors results in very high speed dynamics, with parameters changing in a matter of milliseconds. Conventional PID regulatory controllers may not be fast enough to fully compensate for these quick disturbances.

Emerson delivers compressor controls as a pre-engineered, modular DeltaV™ solution for high-quality compressor control. The solution includes software and services to implement compressor control for centrifugal or axial compressors.

Benefits

If, for any reason, the gas flow through a centrifugal or axial compressor drops below some critical level, it will stall. When that happens, the flow direction inside the compressor rapidly drops or even reverses for a short period and then recovers. This condition is called “surge” and can be very destructive to the compressor. So most compressors will have a recycle or blowoff valve to prevent surge from occurring. If antisurge control is mistuned or unreliable, operators tend to set the antisurge controller setpoint conservatively, and recycle more than needed to avoid the risk of surge. When that occurs, energy spent to compress the gas is being dissipated through the antisurge valve.

The SmartProcess Compressor Solution by DeltaV provides an efficient antisurge control strategy that prevents surge using the minimum necessary recycle or blow-off flow to maintain flow through the compressor above the surge line. The solution operates the compressor safely while simultaneously improving energy efficiency.

Compressors are most often used to control pressure in a vessel, pipeline or header or to supply the required gas flow demand to a process. Either pressure or flow is usually the primary process parameter used to set the compressor load. Compressor performance is determined by how precisely it controls the main process parameter and how much energy it consumes to deliver it.

The SmartProcess Compressor Solution synchronizes multiple control loops to stabilize the main process parameter while, at the same time, minimizing energy consumption.

A dedicated compressor control system that is not supported by the site's automation team means relying on third-party contractors for tuning, repairing or troubleshooting. Getting a field engineer onsite can take days or even weeks, during which time the system will work in manual, jeopardizing compressor safety and efficiency.

The SmartProcess Compressor Solution is based on standard DeltaV control functions which are easy for site personnel to tune, repair and troubleshoot. The algorithm is transparent and customers can identify problems by observing the signals and sequences online and tune configuration parameters themselves.

When two or more compressors are working in parallel with the same suction and/or discharge header, it is crucial that their loads are balanced. Without load sharing control, one may eventually take the load from the other (or others) and drive them towards the surge zone. Without automated load sharing, all compressors may work far away from the zone of maximum efficiency and take frequent operator attention to balance them manually.

The SmartProcess Compressor Solution includes an efficient load sharing strategy that ensures all parallel compressors work in the zone of maximum possible efficiency. When demand falls, all compressors open their recycle or blow-off valves simultaneously.

Control quality depends on response time, reliability and functionality of all devices that make up the total control loop: sensors, transmitters, data transfer channels, controllers and the final control elements. Since compressors can have very quick dynamics, control loops must be as fast as possible to provide the best result. Delays, lags or latencies at every stage need to be eliminated.

The SmartProcess Compressor Solution takes advantage of the "smart" functions of Emerson devices to ensure the minimum response time from the sensing element to the movement of the control valve. Our special diagnostic software detects malfunctions and mistuning for every component in the control loop, increasing system reliability and eliminating false trips.

Startup of a compressor can be a tricky process if performed manually. Controlling compressor load and antisurge valves manually during startup makes it difficult to deliver a relatively stable main process parameter while avoiding compressor surge at the same time. Similarly, safely and smoothly shutting down the compressor requires attention and skill.

The SmartProcess Compressor Solution includes automated startup and shutdown sequencing logic and delivers the fastest possible transition to Run, Stop and Purge states. Unique algorithms allow the operator to manipulate control valves manually, but only to the point where operation is safe, providing extra protection from possible error.

Product Description

The SmartProcess Compressor Solution by DeltaV is designed for the DeltaV controller family, working with smart field devices to improve the compressor operation safety, stabilize the main process parameter and increase energy efficiency.

A standardized, tested DeltaV application library provides a set of Composite Blocks, pre-engineered Module Classes, and graphics that minimize engineering effort and reduce project risk to implement the solution.

Advanced control applications supplied with the DeltaV Compressor Solution, include four main control functions:

- Antisurge Control
- Load Control
- Load Sharing Control
- Start/Stop Sequencing

These modules include a combination of closed-loop and open-loop control functions, calculations of compressor operating points and associated tuning parameters. Many features, including automated sequencing, are pre-configured and can be switched on and off based on the project needs.

Emerson's smart devices, including advanced diagnostics and tuning capabilities can be accessed from the AMS Device Manager. The Entech Toolkit is included to capture the fast process dynamics associated with surge testing of the machine.

Note: *the Entech Toolkit is quoted separately from the DeltaV Compressor Solution licenses.*

Control Library

All internal calculations of the compressor parameters are performed in standard engineering units to assure the consistency of dimensions and eliminate the need for additional scaling coefficients. All input signals used in the Antisurge Control Modules are preprocessed to convert to standard engineering units.

The current operating point for each compressor stage is calculated using reduced variables that are invariant to suction process conditions. Depending on the stability of the gas composition, either compression ratio or polytropic head can be used to compensate for changes in molecular weight. The current operating point becomes the primary controlled variable for the Antisurge Control Module and the balancing criteria for the Load Sharing Control Module.

The SmartProcess Compressor Solution includes the following components:

- DeltaV Composite Library: Extensive library of modules for input validation, calculations, control, clamping and decoupling functions that are configured to the project requirements.
- DeltaV Control Module Classes:
 - Antisurge Control
 - Load Control
 - Load Sharing Control
- DeltaV Graphic Templates:
 - Dynamic Compressor Map
 - Antisurge Control Faceplate
 - Load Control Faceplate
 - Antisurge Control Configuration Faceplate
 - Load Control Configuration Faceplate
- DeltaV Sample Configuration: a setup for two parallel air compressors driven by an electric motor or turbine. Including simplified dynamic simulation.
- Documentation: Installation Guide, Operation Manual and Configuration Guide.

Consultant Engineering Services

Emerson's Solutions Consultants provide standard engineering services to design, configure, install and commission a complete SmartProcess Compressor Solution. The scope can cover individual compressors or complete multi-sectional compressor trains or several parallel compressor trains. At the start of a project, our consultants will review the process, operating objectives, constraints and economics to design the control strategy, benchmark current performance and develop a project execution plan.

Compressor Control requires the fastest DeltaV task execution time. Recommended implementation is to use separate, redundant DeltaV PK Controllers per compressor train to ensure reliability of the controller operation and more convenient maintenance.

A standard methodology used for implementing the SmartProcess Compressor Solution is as follows:

- FEED study and scope definition
- Kickoff meeting
- Develop Bill of Material for all required DeltaV control system components
- Develop Compressor Control strategy
- Identify field components that require repair, replacement or upgrade
- Create control system diagrams and architectures
- Issue project documentation
- Supply all required system components
- Configure DeltaV modules
- In-house simulation and testing
- Commissioning and tuning
- Operator and Engineer Training

Most of these activities are done off-site by an Emerson Compressor Control expert.

Emerson, through our field services offices and Emerson Impact Partners, offers 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 an implementation project:

- Customer witnessed Factory Acceptance Test
- Instrumentation Assessment: An Emerson consultant will identify any malfunctioning or missing instrumentation or valves affecting compressor performance.

For additional information on Emerson’s compressor control services, please see solution datasheet.

DeltaV Hardware, Software and Services

The SmartProcess Compressor Solution uses standard DeltaV modules that are implemented in the controller. The additional load these modules place on a DeltaV system is expected to be significant, since the execution frequency for the Compressor

Control functions is typically much faster than most regulatory controls. Therefore, implementing each compressor train in a separate, redundant controller is recommended.

The control logic is configured by the Emerson engineering team with these services being quoted separately from the licenses based on the overall project scope.

PK Controller Standalone

The SmartProcess Compressor Solution can be implemented as a standalone system using the DeltaV PK Controller. The solution can be deployed as a headless system, local HMI, or integrated with an existing HMI with built-in OPC UA protocol.

DeltaV Compressor Solution Licensing

The SmartProcess Compressor Solution is licensed on a per-compressor basis. On installation of the software, a standard “click-wrap” license agreement stipulates the terms of the license and restricts use to the specific compressors for which it was licensed.

License Ordering Information

Description	Model Number
SmartProcess Compressor – Main License for 1 compressor. Includes 1 Load Control Loop and 1 Antisurge Control Loop. A Main License is required for each compressor.	VF1058B1C1
SmartProcess Compressor – Extension License for 1 Additional Antisurge Control Loop. Requires purchase of VF1058B1C1 for the same compressor.	VF1058E1C1
SmartProcess Compressor – Extension License for 1 Additional Load Control Loop. Requires purchase of VF1058B1C1 for the same compressor.	VF1058E2C1
SmartProcess Compressor – Load Sharing Control. Required to control multiple, parallel compressors; 1 per compressor. Requires purchase of VF1058B1C1 for the same compressor.	VF1058CLSC
EnTech Toolkit Standalone	VF9141

Services Ordering Information

Contact Emerson’s sales team and provide the basic information required to define the scope of the solution:

1. Process P&ID containing compressor and its full recycle/blow off path along with all transmitters currently available to measure compressor flow, suction/discharge pressure and temperature.

2. Compressor datasheet, where applicable.
3. Existing system architecture, where applicable.
4. Transmitters datasheets, where applicable.

If the requested information is not be available, it is possible to order a FEED study to define the required scope.

Related Products

- Fisher Antisurge Valves. Fast enough to allow the compressor to operate as close to the surge line as possible. Optimized valve performance, together with online tuning make this valve unique for antisurge applications.
- Rosemount Transmitters. Deliver fast and reliable process measurements and are able to perform the rate-of-change calculation much faster than the controller.
- DeltaV Distributed Control System
- DeltaV PK Controller

Prerequisites

- DeltaV v12.3 or higher

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