SmartProcess™ Compressor

- 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

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.

Every time process conditions around the compressor change, compressors can become inefficient or even unstable. The high rotating speed and large energies being 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 SmartProcess™ Compressor, a pre-engineered, modular solution for high-quality compressor control. The solution includes software and services to implement compressor control for any centrifugal or axial compressor.

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 of 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 they need just to avoid the risk of surge. When that occurs, energy that was spent to compress the gas is being dissipated through the antisurge valve.
Emerson’s SmartProcess Compressor 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. So either pressure or flow are usually the main 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.

Emerson’s SmartProcess Compressor synchronizes multiple control loops to stabilize the main process parameter while, at the same time, minimize 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 the system will work in manual, jeopardizing compressor’s safety and efficiency.

Emerson’s SmartProcess Compressor 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’s very important to balance their loads. In the absence of load sharing control, one of them 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.

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

The quality of control 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.

Emerson’s SmartProcess Compressor 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 the 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.

Emerson’s SmartProcess Compressor includes automated startup and shutdown sequencing logic and delivers fastest possible transition to Run, Stop and Purge states. Special 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

Emerson’s SmartProcess Compressor application 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 SmartProcess 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 point and associated tuning parameters. Many features, including the 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. A special high-speed historian is included to capture the fast process dynamics associated with surge testing of the machine. Note: High speed historian is quoted separately from the DeltaV SmartProcess Compressor licenses based on the required number of tags.
SmartProcess Compressor 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. Either compression ratio or polytropic head can be used, depending on the stability of the gas composition, to compensate for changes in molecular weight. The current operating point becomes the main controlled variable for the Antisurge Control Module and the balancing criteria for the Load Sharing Control Module.

The DeltaV 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:
  - 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 electric motor. Including simplified dynamic simulation.

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 compressors or complete multy-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 SmartProcess Compressor implementation is to use separate, redundant DeltaV controller per compressor train to ensure reliability of the controller operation and more convenient maintenance.

A standard methodology is used for implementing SmartProcess applications 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 a certified 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 a SmartProcess 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

SmartProcess Compressor applications are 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 it is recommended to implement each compressor train in a separate, redundant controller.

The control logic is configured by the Emerson engineering team and the engineering services have to be quoted separately from the licenses based on the overall project scope outside of the SmartProcess Compressor package configuration.

PK Controller Standalone

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

SmartProcess Compressor License

The SmartProcess Compressor 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

<table>
<thead>
<tr>
<th>Description</th>
<th>Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>VF1058B1C1</td>
</tr>
<tr>
<td>SmartProcess Compressor – Extension License for 1 Additional Antisurge Control Loop. Requires purchase of VF1058B1C1 for the same compressor.</td>
<td>VF1058E1C1</td>
</tr>
<tr>
<td>SmartProcess Compressor – Extension License for 1 Additional Load Control Loop. Requires purchase of VF1058B1C1 for the same compressor.</td>
<td>VF1058E2C1</td>
</tr>
<tr>
<td>SmartProcess Compressor – Load Sharing Control. Required to control multiple, parallel compressors; 1 per compressor. Requires purchase of VF1058B1C1 for the same compressor.</td>
<td>VF1058CLSC</td>
</tr>
<tr>
<td>Annual Application Support for SmartProcess Compressor; 1 per system ID.</td>
<td>VF1058S1</td>
</tr>
</tbody>
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Services Ordering Information

Contact Emerson’s sales team and provide the basic information required to scope up the full 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 would not be available, it is possible to order a FEED study services to scope up the control system.

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™**

- **DeltaV™ PK Controller**

Prerequisites

- DeltaV v12.3 or higher