



Compressor Anti-Surge Control Application

This document explains how a DeltaV system was used in a compressor anti-surge control application.

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Introduction

Surges occur when the compressor outlet pressure is too high in relation to the flow through the compressor. The flow can change rapidly when there is a sudden change in the load that the compressor is expected to deliver. If the surge is not controlled, the compressor can be destroyed. An anti-surge control strategy is designed to protect a compressor from these surges.

The typical methods for accomplishing surge control are either a blow-off to atmosphere or recirculation from the outlet to the inlet of the compressor. The anti-surge control strategy is tightly integrated with the compressor load control strategy.

Installation Details

The application comprised a 3.2 MW compressor supplying air to an air separation plant. The air from the compressor was passed through a molecular sieve into a column (coldbox) in a fairly steady flow (approx. 90,000 Nm³/h).

The hardware that was used for this application comprised standard DeltaV I/O (analog and digital) connected to standard Rosemount transmitters (non-HART). A DeltaV M3 controller was used for the load control and anti-surge control.

The compressor was a multi-stage "turbo". The incoming air was compressed in the first stage and then passed through a heat exchanger to be cooled off before being injected into the second stage.

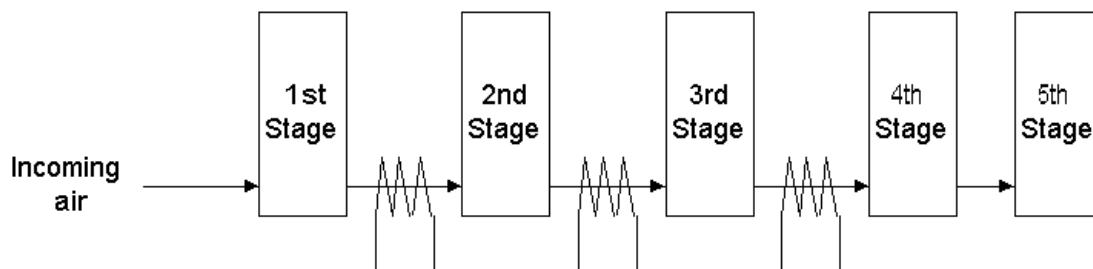


Figure 1. Compressor details

Control Strategy

The following control strategies (see Fig. 2) were executed by the DeltaV controller.

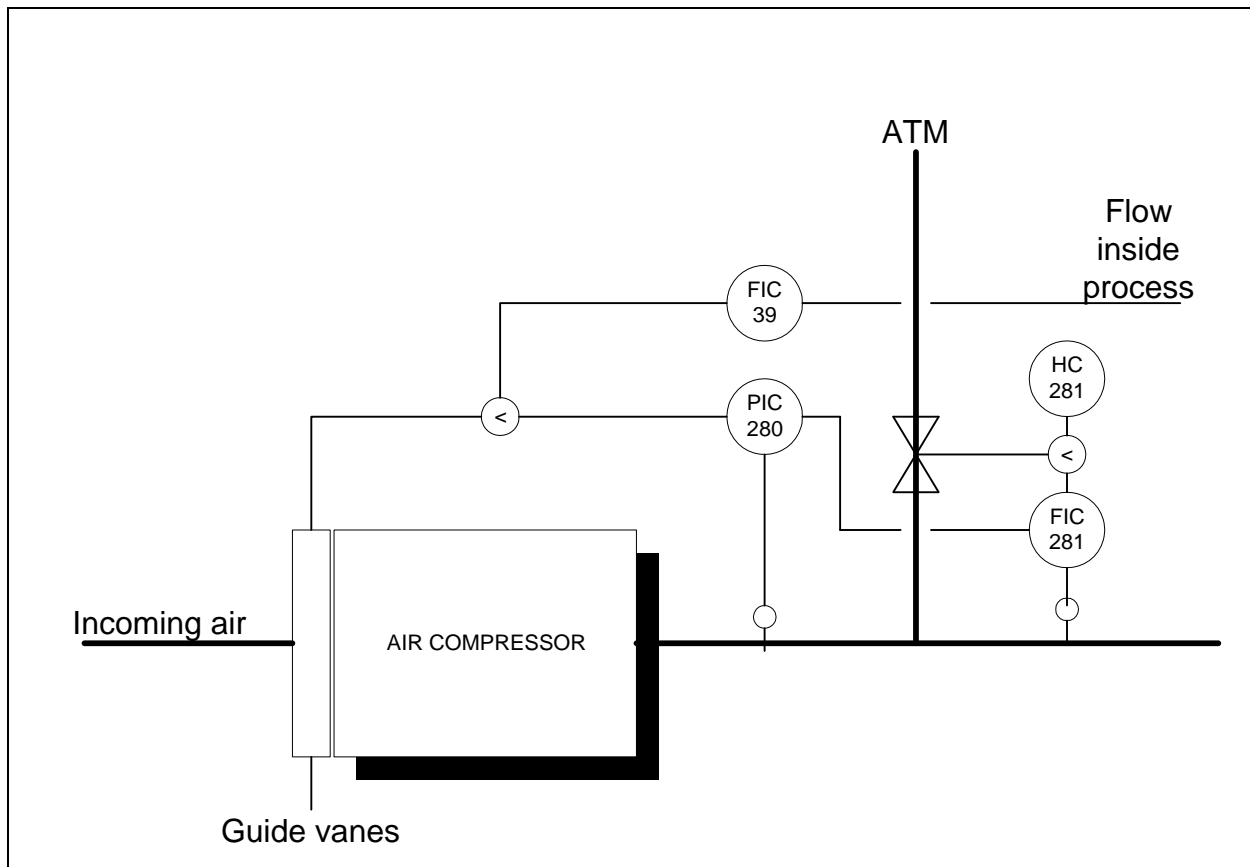


Figure 2. Control Strategy

Load control (FIC-39, PIC-280)

The load control comprised two loops connected to the inlet guide vanes via a low selector function. The lowest output from either FIC-39 or PIC-280 was sent to the guide vanes. In this way both the flow and pressure from the compressor could be controlled.

Anti-surge control (FIC-281, HC-281)

The differential pressure across the compressor was measured. In the example, the pressure before the compressor was estimated to be atmospheric pressure, so only the pressure after the compressor was measured. This means that the control strategy will try to keep the flow and pressure within the area under the curve. Normally, the compressor is operated far away from the curve. A surge occurs when the pressure is too high in relation to the flow through the compressor.

The anti-surge control consisted of two loops connected to a blow-off valve via a low selector block. FIC-281 was used in cascade mode with the setpoint calculated from the surge line (see Fig. 3) provided by the machine



manufacturer. The surge line is derived from testing the compressor at several points of pressure to see at what flow (FI-281) the compressor starts surging. From this line, a safety line a few percent points below was created. The pressure PI-280 was sent through the safety line calculation to produce the setpoint for FIC281. If the control response has to be very quick near the surge line, a gain scheduling (and possibly the reset and rate as well) may be used to change the gain, depending on how close to the surge line the compressor is working.

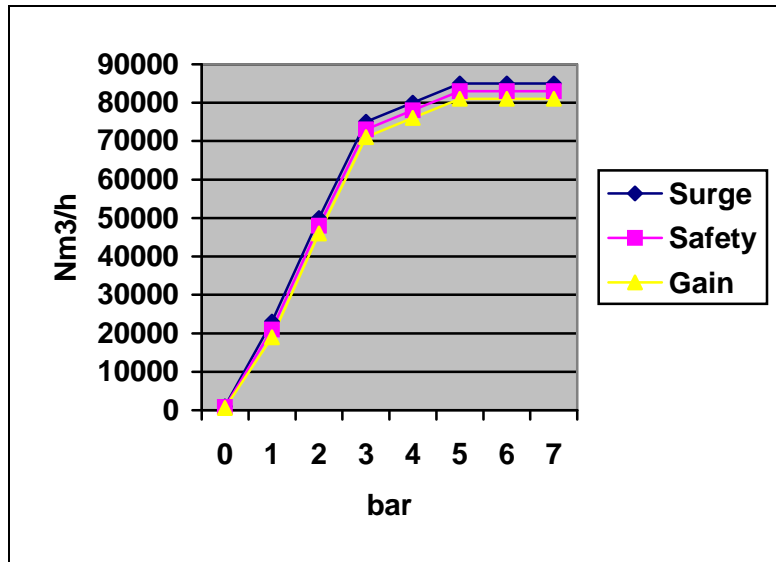


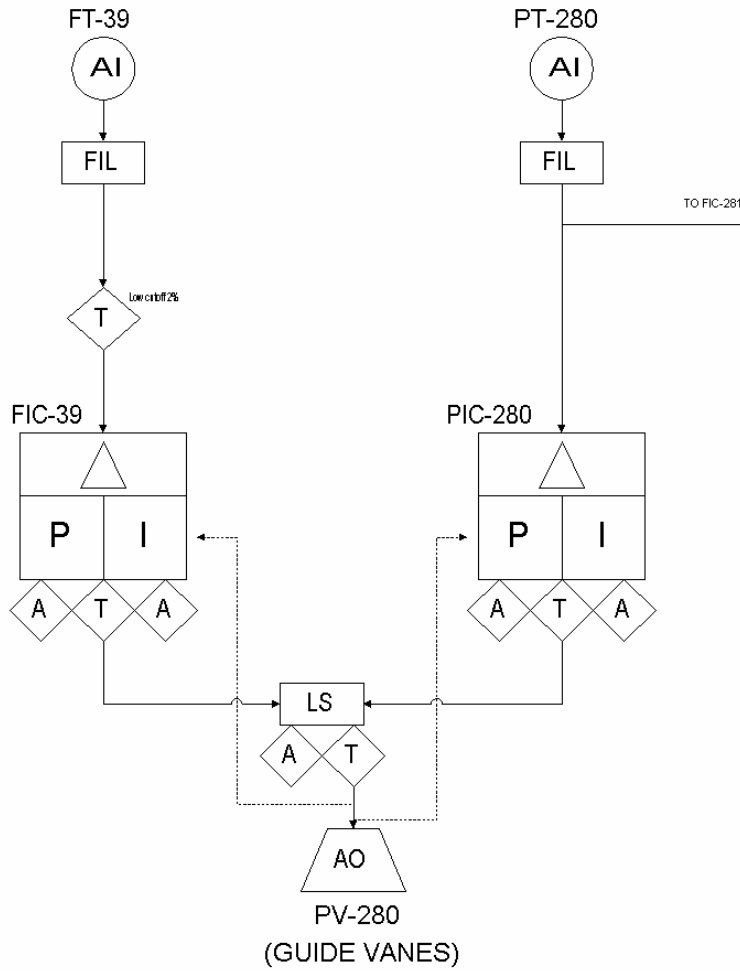
Figure 3. Surge Line

For this application, all the DeltaV control modules were set to run at 100 ms scan rate. Letting the compressor run at a minimum flow into the process and allowing the anti-surge valve to do its work was used as a test. The surge control held the compressor at the safety line.

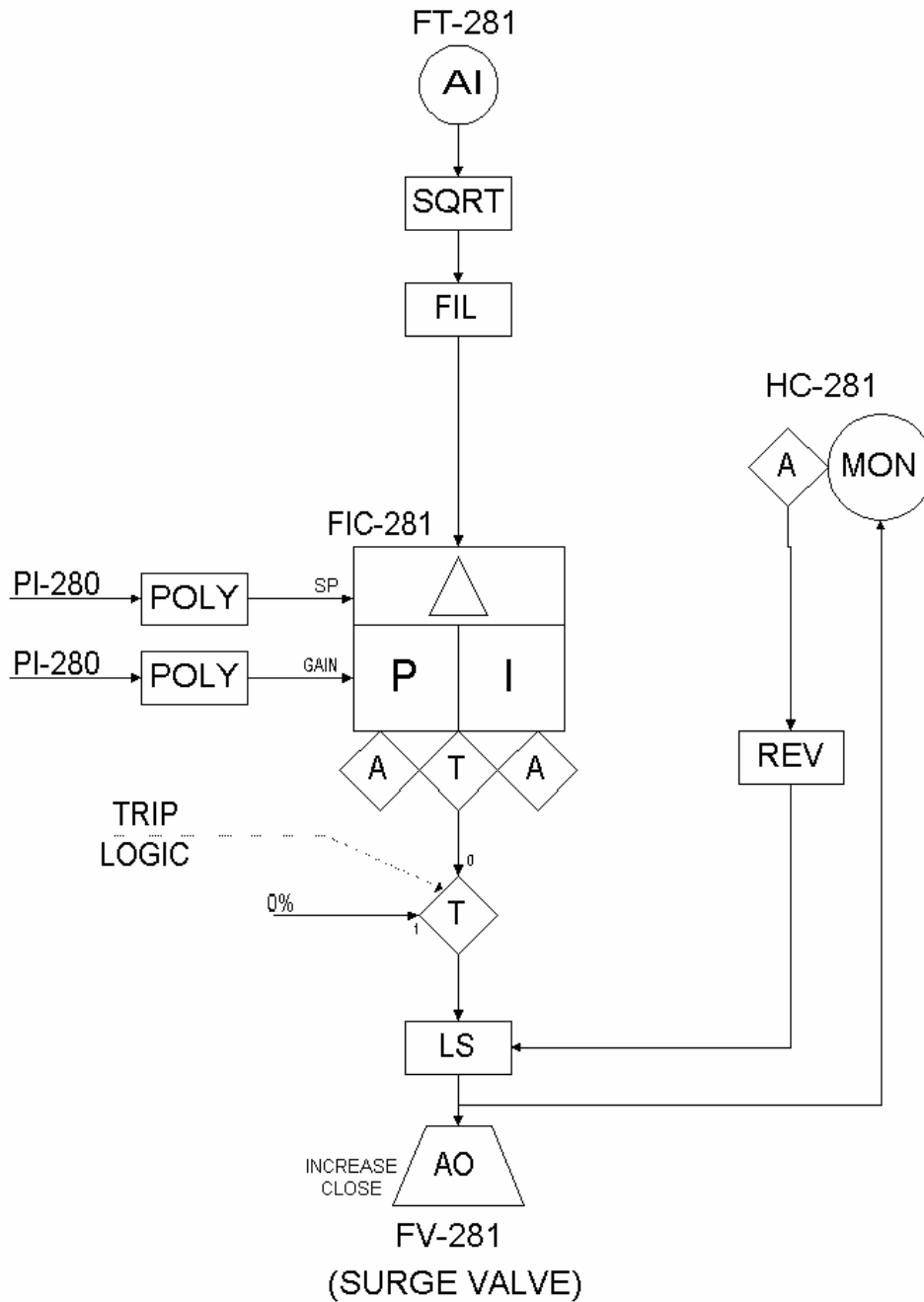


The following SAMA diagrams detail the control strategy.

LOAD CONTROL



ANTI-SURGE CONTROL





References

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