

# Compressor Control Systems

## Overview

Proeon Systems Ltd. embodies over 25 years experience in the design and implementation of complex highly critical control systems for a variety of industries.

Proeon Systems Ltd. supply a range of Load control systems for Turbo-compressors using a variety of Programmable Logic Controller (PLC) platforms. The compressor control systems can be integrated with the engine control systems if required and are supplied with extensive diagnostics and communication facilities enabling an easy interface to other plant equipment, SCADA systems or DCS platforms.

Our extensive experience with some of the major international Oil and Gas companies provides the company with an understanding of the industry enabling us to implement control systems of the highest quality.

## Solutions

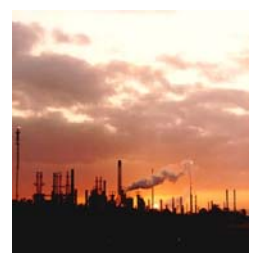
Proeon Systems Ltd. can provide a complete compressor control solutions to manage the connected loads and the prime movers. The systems include Anti-surge control systems and Station control. All systems make use of Programmable technology to accurately monitor and control the compressors and other systems using industry standard controllers

## Facilities

The compressor control solutions are built around integrated high speed PLCs and local HMI systems to monitor, log and oversee the connected compressor systems. The Compressor controllers have extensive communications capabilities to allow the connection of remote 3rd party systems such as the Turbine Control Panels. The compressor control system may be connected to host systems to permit data to be made available throughout the plant.

### Key Points..

- PLC based control systems using Rockwell and Siemens hardware
- Closed loop control of compressor operating point with open loop intervention
- Integration with Turbine governor controls reduces hardware and interfaces
- Integration with station control software
- Dynamic compressor operating point monitoring
- Extensive communications to HMI, DCS and SCADA systems



**Innovatively Engineered Solutions**

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## Control platforms

The compressor control systems are typically based on a Programmable Logic Controller networked to one or more HMI workstations.

The PLC will interface to either local or distributed hardwired I/O to acquire the compressor status, pressure, temperature and flow measurements etc. The control platforms may be either Rockwell Controllogix or Siemens S7/400, although the controller may be run on other PLC platforms if required and if these platforms meets the performance requirements.



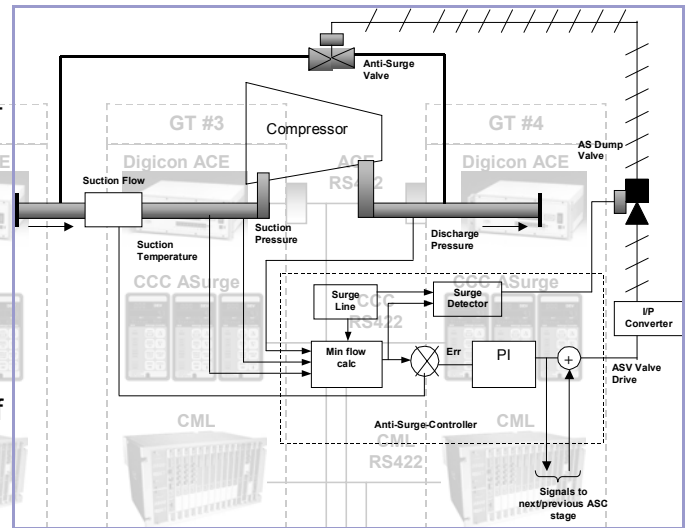
## Integration

The compressor control package can be fully integrated with the turbine control panels and programmable governors to provide a single controller capable of controlling both the prime mover and the driven load with the minimum of interfaces.

## Anti-Surge control

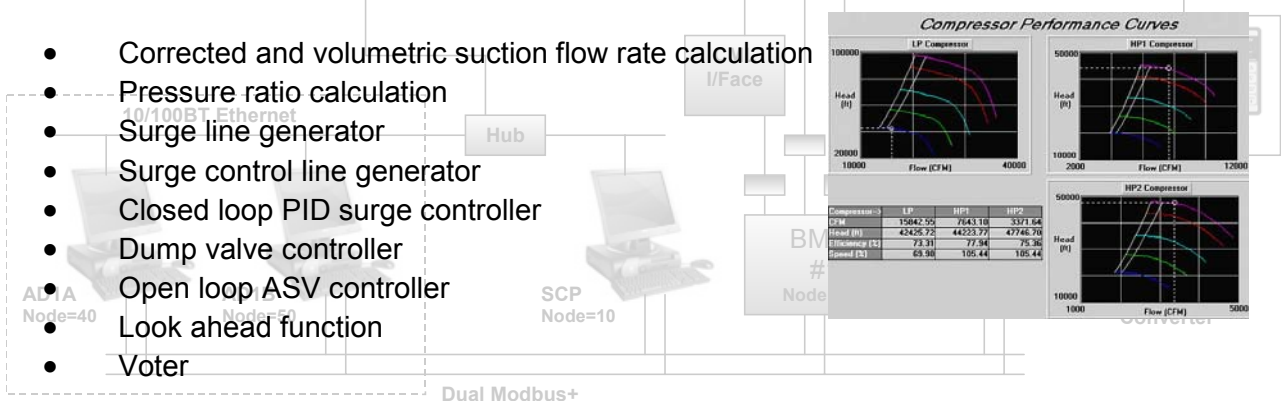
The purpose of the compressor Anti-Surge Controller (ASC) is to prevent surge from occurring within the compressors. Surge occurs at specific combinations of head and flow rate as defined by the performance curves for the compressor.

The ASC works by opening the Anti-Surge Valve, (ASV) (also called a recycle valve) across the compressor stage that is in danger of surging. This has the combined effect of increasing the suction flow, decreasing the discharge pressure, decreasing the head and hence moving the compressor operation away from surge.



The ASC contains the following main functional blocks:

- Corrected and volumetric suction flow rate calculation
- Pressure ratio calculation
- Surge line generator
- Surge control line generator
- Closed loop PID surge controller
- Dump valve controller
- Open loop ASV controller
- Look ahead function
- Voter



## Corrected and Volumetric suction flow rate calculation

Both the corrected and volumetric suction volumetric flow rates are measured by a dP cell and orifice plate in the suction line of the compressor.

## Pressure ratio calculation

The pressure ratio is calculated as the ratio of Discharge Pressure to Suction pressure.

## Surge Control Line

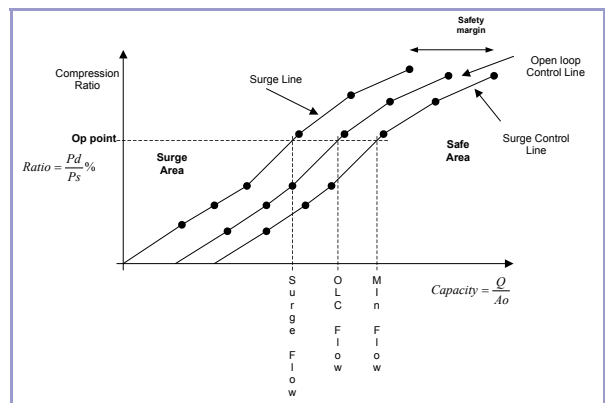
The surge line for the compressor provides a map of compression ratio vs flow. If the ASC uses the surge line alone as the basis of control, then it is likely that the ASC will not act in time to prevent surge. Therefore, a Surge Control Line (SCL) is generated by the ASC that uses a safety margin to ensure that the ASV is controlled before the compressor enters the surge region.

The generation of the surge control line uses the predefined surge line and then applies both a calculated percentage offset set and a fixed offset to generate a new SCL. The effect of this is to produce a surge control line that is offset from the surge line.

## Closed loop Surge controller

The closed loop surge controller is based on a PID controller the set-point (SP) of which is the flow derived from the surge control line and the process variable (PV) of which is the actual flow rate.

The output of the closed loop controller is subject to a feed forward term from other ASCs in the train. This provides the ability for the ASC to respond immediately to prevent the compressor going into surge should the other compressor in the train do so. The output of the closed loop surge controller is fed to the Voter.



## Manual control

The ASV may be placed in Manual mode. When in Manual mode the ASV output is ramped open or closed as defined by the Manual set-point. The Manual set-point is subject to a rate limiter and is output to the Voter.

## Sequence control

The ASV may be controlled by the overall train sequencer. The sequence set-point is subject to a rate limiter and is output to the Voter.

## Look ahead function

The look ahead function provides anticipatory action when the compressor suction flow rate rapidly falls.

The function provides an output flow calculation to be added to the surge control line flow to form the flow set point to the Closed Loop Surge PID controller. The output flow calculation is proportional to the absolute value of the flow difference between the current volumetric flow and the surge control line and is rate limited for decreasing values of flow difference with respect to time so that its maximum decreasing rate is equal to a preset value.

## Open loop control

The open loop control module provides action should the compressor flow fall below the open loop control line. The open loop control line is set below the surge control line by a fixed gain.

Should the flow rate fall below the Open Loop Control line, the open loop controller will automatically increment the ASV position in preset step increases. Step increases continue at an adjustable interval up to the maximum ASV position. After the compressor flow has increased above the surge control line the open loop control output is reduced to zero at a preset rate.

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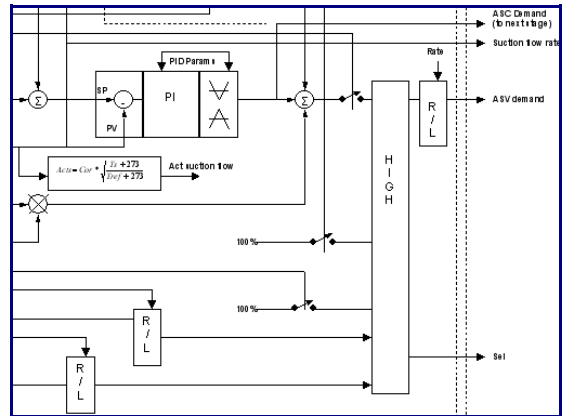
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## Voter

The voter accepts the outputs from all the control elements and provides a “highest wins” output to the ASV.

## Alarm handling

On detection of a sensor failure within the ASC an alarm will be generated to indicate the source of failure. If the failure has occurred whilst the ASV was partially or fully open under the control of automatic anti-surge control, the ASV is fully opened, the automatic surge control operation disabled, and the recycle valve placed under manual control.



## Surge dump valve control

The surge dump valve is a fast acting valve that dumps pressure to the ASV and causes the valve to open. The surge dump valve is controlled by digital output that is operated as soon as the compressor enters the surge area of the surge curve. The output is then held on until the compressor re-enters the safe area. The output to the surge dump valve is fail safe. i.e. the output de-energises to open the valve.

## Station control

The Station controller provides load-sharing and is designed for a number of different load sharing strategies including cascaded compressor stages and parallel flow routes.

## Constant distance from Surge Control Line

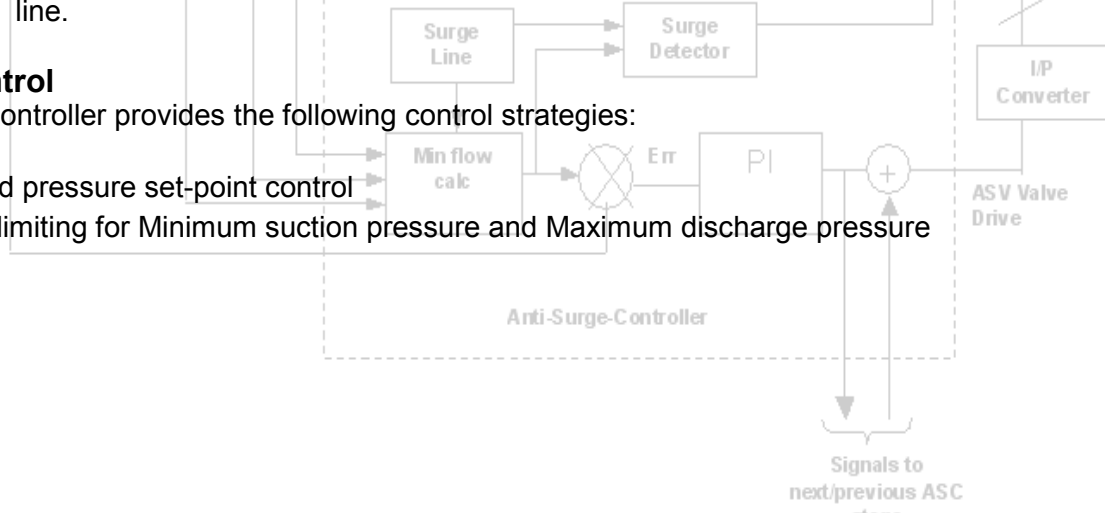
The station controller includes a control loop to maintain the flow balance through the compressors by determining the flow difference between the compressors and providing a balancing offset in order to keep the flow difference as close to zero as possible.

Unless normalized flow calculations are used, the flow balancing control relies on equal sizing and performance of the gas compressors. Where two or more different compressors / gas turbines is best achieved by controlling the operating points distance from the control line.

## Pressure Control

The Pressure Controller provides the following control strategies:

- Demanded pressure set-point control
- Pressure limiting for Minimum suction pressure and Maximum discharge pressure



## Proeon Systems Ltd.

Cavell House — Stannard Place — St. Crispins Road — Norwich — NR3 1YE — Norfolk — UK  
 T :+44 (0)1603 821202 F:+44 (0)1603 416738 E: proeon@proeon.co.uk W: www.proeon.co.uk