WOODWARD

Advanced Incipient Surge Detection

Woodward's advanced incipient surge detection algorithms are based on over 25 years of leveraging its field proven petrochemical and pipeline compressor control and protection experience. These algorithms allow compressor trains to operate at peak efficiency, while protecting each stage of a compressor from potentially catastrophic surge events.

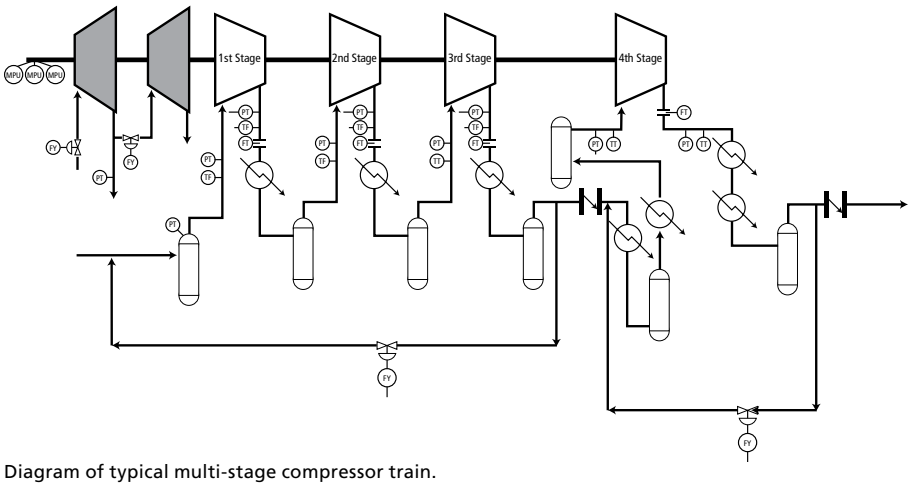


Diagram of typical multi-stage compressor train.

Field proven decoupling methods safely and reliably sequence parallel process compressors on or off line, or manage series compressors during normal plant operation and unexpected transient conditions.

Woodward's patented rate control and surge prevention logic differentiate its compressor control and anti-surge protection from that of other solution providers. These algorithms have long been used and qualified by compressor OEMs such as MHI, Siemens and GE.

Utilizing Woodward's patented technology, the Rate Control PID is a key defense tool in protecting a compressor stage or train from potentially damaging surge events. This PID senses acceleration of the compressor control-point toward the surge line. When the correct conditions exist, it reacts to quickly position the respective compressor stage or train farther from its surge line. Depending on the system configuration and associated decoupling logic used, this incipient action may cause a change in the recycle valve position, unit speed, or throttle position.

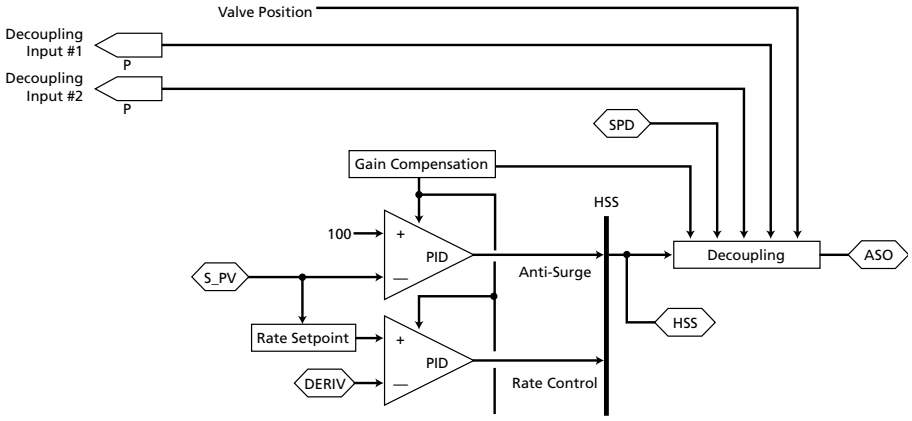
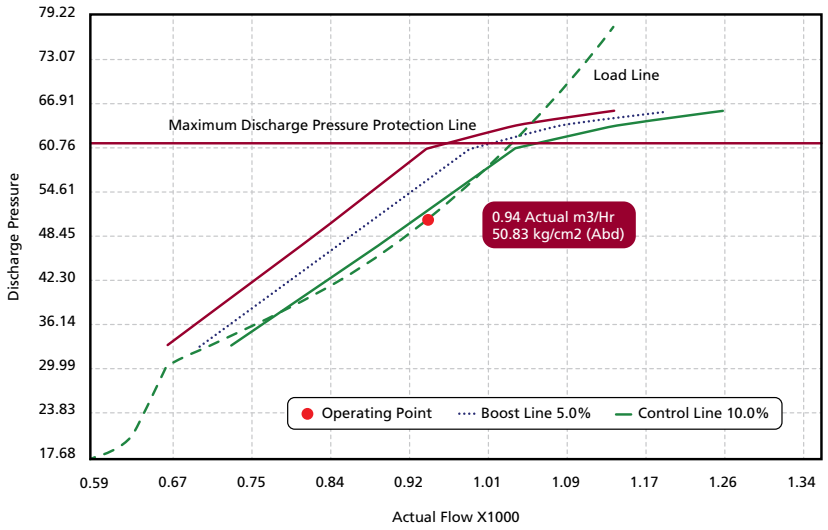


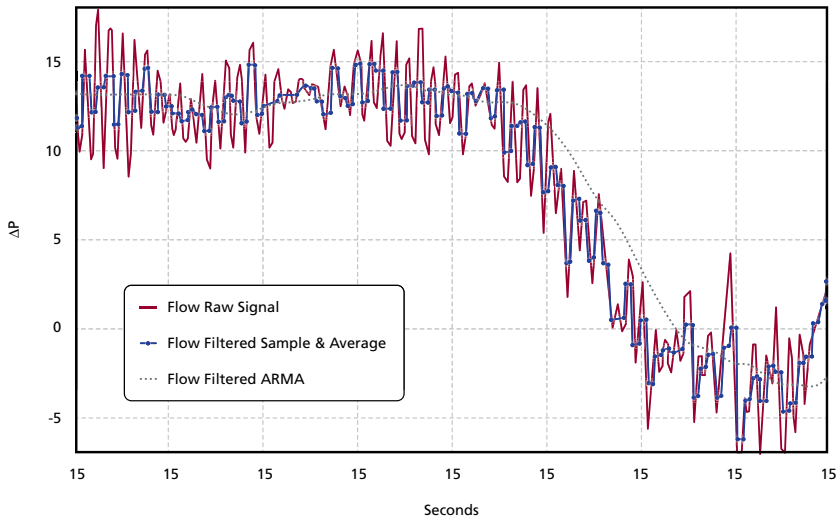
Diagram of typical surge control logic.

Woodward's multi-stage decoupling logic allows upstream stages to anticipate a possible surge event when downstream stages are either in or close to a surge condition. The advantage of such incipient surge detection is quicker total train response time to possible surge events, resulting in quicker transition back to full system production and best system efficiency levels.



Surge map loop 1.

Compressor flow is an essential signal used to calculate unit performance and location of the compressor control point relative to the surge line. However, due to flow disturbances and turbulence within unit piping, this signal is typically very noisy. This noise makes it extremely hard to calculate a compressor stage's control position within the stage's designed operating envelope, or to use it to anticipate a related surge event. Woodward's patented scrolling flow filter technology removes flow disturbance/turbulence noise and outputs a core flow signal with minimal lag time. As incipient surge detection logic utilizes the derivative (rate of change of the control point) to anticipate a surge event, it is imperative that the signal be as fast as possible while not allowing inaccuracies to propagate throughout the system.



Flow signal filtering.

Woodward's incipient surge detection algorithms utilize the following seven basic levels of protection to anticipate and protect equipment from surge events:

1. Stage to Stage Decoupling – Decouples the interaction of a compressor stage is a surge, preventing it from affecting the other stages of the compressor train.
2. Speed/IGV to Stage Emergency Decoupling - Anticipates a surge event by opening the recycling valve upon a sudden load change (speed/IGV) that could bring the compressor operating point too close to the surge line.
3. Rate PID Controller – During fast surge events, this incipient controller uses the location, direction, and derivative of the compressor control point to modulate the recycle valve. This keeps the compressor control point away from its surge line/area.
4. Surge Control Line PID Controller – During slow surge events, this controller manages the position of the loop recycle valve to ensure that the compressor control point stays a pre-determined margin away from the surge line/area.
5. Boost Function – This anticipation function is the last line of defense against surge. It steps the recycle valve open to a pre-set margin, moving the compressor far enough to avoid a surge condition, while not moving it far enough to negatively impact the production process.
6. Max Discharge Pressure Function – An incipient protection function which opens and modulates the recycle valve. This enables the compressor to move away from a surge condition or unacceptable running condition.
7. Min Suction Pressure – An incipient protection function which opens and modulates the recycle valve if minimum suction pressure occurs. This enables the compressor to move away from a surge condition or unacceptable running condition.

Full knowledge of the compressor's purpose relative to the process, and of the compressor's installation specifics are extremely valuable; they enable the system engineer to anticipate external factors likely to affect the incipient surge detection logic (such as recycle piping loop configuration, overall process dynamics, etc.) This knowledge also enables successful application of decoupling, pre-pack and other supporting features to avoid full surge events. As surge events can be detrimental to the operation and life of a compressor, it is also recommended that engineers use operation-specific simulation tools (such as Woodward's NetSim™ simulation package), to validate the incipient surge detection logic and related responses before actual unit operation and after any major controller change.

Woodward's NetSim™ simulation package enables users to reduce compressor commissioning time and risk as well as train system operators prior to compressor operation. By importing the OEM's actual compressor model into the NetSim program system engineers can actually identify operation problems before going to the field. This powerful simulation program produces a virtual test stand in the office or in the field, on a desktop or on a laptop computer. Learn more by downloading the NetSim Control Simulation Software brochure (52120) at www.woodward.com (or request this document from your Woodward representative).

Woodward, Inc.
Corporate Headquarters
phone: +1 (970) 482-5811
fax: +1 (970) 498-3050
email: TurboInfo@woodward.com

Woodward Governor Nederland BV
Phone: +31 (23) 5661111
Fax: +31 (23) 5636529
Email: info_nl@woodward.com

www.woodward.com/Application-IndustrialTurbine.aspx

51418-2 1/12