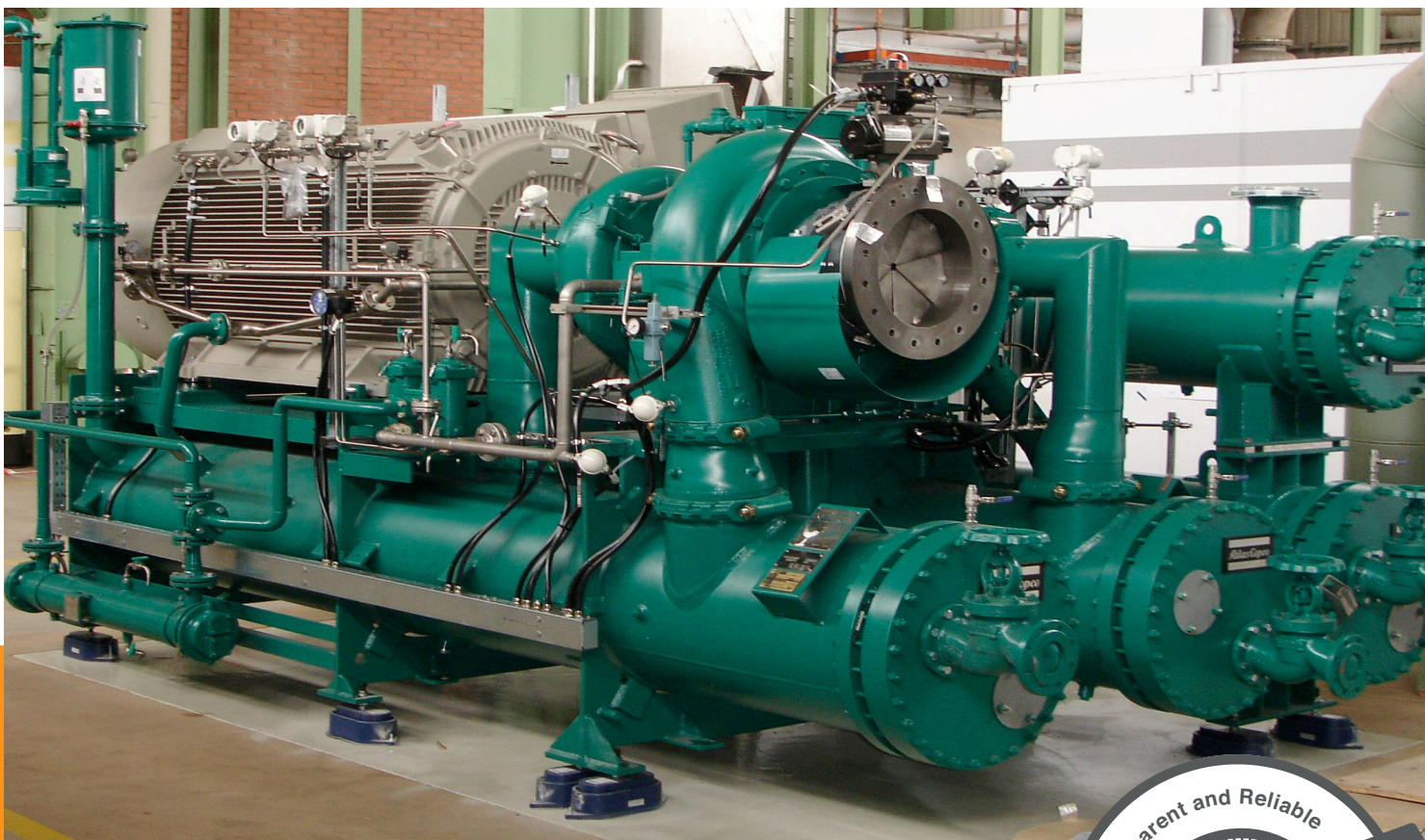


Anti-surge Control for Turbocompressors based on Siemens Simatic S7-1200/-1500



Stable and Efficient Operation



“A turbocompressor surges”,

if the operating point of the compressor leaves the stable area of the characteristics map, either due to a reduction of the flow or due to an increase of the discharge pressure. Surging is characterized by a cyclic flow and reverse flow of the compressed medium, and is accompanied by high vibration, pressure surges and a rapid temperature increase within the compressor. Even after a short period, persistent surging can lead to severe compressor damage.

Particularly axial compressors and radial compressors with open impellers are at risk. The flow malfunction can have disastrous effects, even on the downstream process.

No control system can change the characteristics of the compressor – but: the kmo Anti-Surge Control provides functions that maximize the usable range of the compressor characteristics.



Higher Efficiency

is provided by kmo turbo's anti-surge control due to optimum utilization of the compressor characteristics.

Operator Benefits

- Industrially approved standard Siemens components available world-wide
- Maximum control range: uncertainties of a theoretical characteristic diagram are eliminated by measuring the surge limit during commissioning. Special functions enhance the control performance.
- Unique functions for the analysis of surging
- High-resolution recording of the surge-relevant signals
- Web-based user interface: without installing special software, parameterization and diagnosis is possible with any network-compatible device (PC, tablet, smartphone)
- Simple integration into higher-level controllers via Profibus, Modbus-TCP etc.

Why both, Anti-surge Control and Reverse-flow Protection?

The anti-surge control ensures a stable operation. When the surge limit is approached, the flow of the compressor is kept at the lowest possible value due to a controlled opening of a blow-off valve. If this control intervenes too late or not at all, the compressor will inevitably surge. Only then the reverse-flow protection is activated. Its task is to then prevent damage caused by persistent surging using appropriate control interventions.

A reliable anti-surge control is dependent on several measuring signals. Due to the fact that these signals may be susceptible to failures, an anti-surge control alone does not provide a comprehensive form of protection. Most of the measuring errors are caused by leaky sensor lines, by sensor lines in which liquid has accumulated or by a drift of the zero point or measuring range. The surge limit is influenced by temperature, molecular weight and speed, but also by coating and wear of the blading. Not all of these influencing factors can be recognized and corrected by an anti-surge control.

Thus, only the application of an overriding reverse-flow protection ensures maximum security of the compressor.

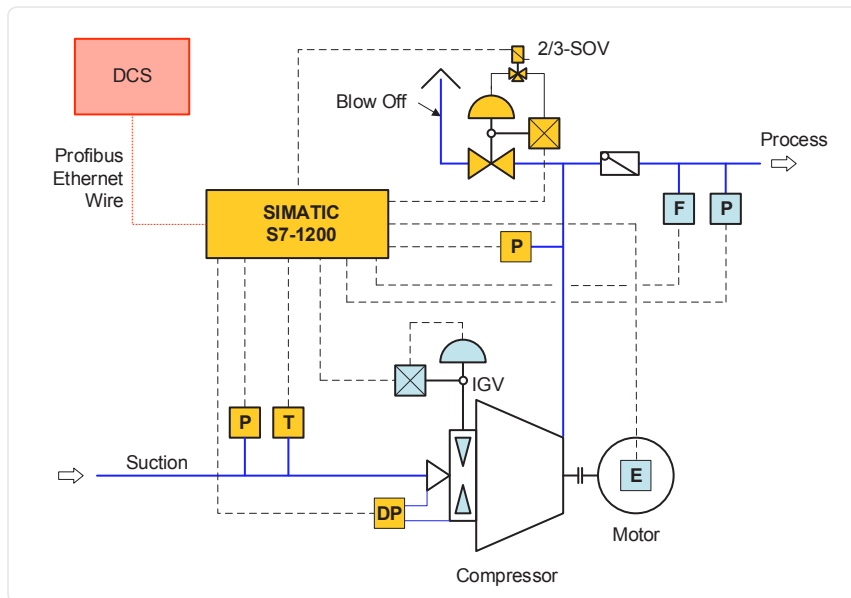
Perfect interaction

Anti-surge Control and Process Control

The process controller (net-pressure, flow rate) acts on the flow adjustment (e.g. inlet guide vanes), the anti-surge control acts on the blow-off or bypass-valve. Due to the mutual influence, the two controllers must communicate; it has proven to be a good idea to integrate the process control into the anti-surge control. The intervention of the anti-surge control system means that the flow rate adjustment has reached the MIN position and a further reduction must be prevented.

Special features of the kmo process control:

- Either the net-pressure or the flow rate can be controlled (jumpless switch-over)
- The process controller can be operated externally, e.g. via the control system
- The process controller primarily acts on the guide vanes, in case of split range also on the blow-off valve
- Integrated limiting controller for motor current and net-pressure



Scheme of a turbocompressor with anti-surge control, reverse-flow protection and process control (option 6)

Hands-on, well designed, coherent

The characteristic maps provided by the compressor manufacturers show the discharge pressure plotted over the mass flow. It is common practice to map the compressor characteristic in terms of control technology. In this respect, an anti-surge control is a pressure control with guided set point (flow). The control element is a blow-off or bypass valve. Mass flow measurement is complex and fault-sensitive; it requires three transmitters and a standardized differential pressure sensor, which inevitably causes an additional pressure drop.

Instead of using a calculated map, **kmo turbo** recommends to measure the surge line during commissioning. In case of an empirically determined surge limit, it is sufficient to connect a measured volumetric flow signal (dp-signal) to the controller instead of the mass flow. With most compressors, the suction line has a larger diameter than the suction flange of the compressor. The pressure drop over the conical transition is an ideal volumetric flow signal.

Scheme of a turbocompressor with anti-surge control, reverse-flow protection and process control (option 6)

Option	Anti-surge Control	Reverse-flow Protection	Process Control	API670
1	✓			
2		✓		
3	✓		✓	
4	✓	✓		
5	✓	✓		✓
6	✓	✓	✓	
7	✓	✓	✓	✓

For special requirements (e.g. variable molecular weight), specific control algorithms can be implemented.

Special Functions with Added Value

The kmo anti-surge control offers numerous special functions for stable and trouble-free operation at maximum control range:

- **TN reduction:**
Improvement of the control dynamics by increasing the speed of the controller as the control deviation gets larger
- **Dead time minimization:**
Improvement of the control dynamics by largely eliminating the conceptual dead time before the valve starts to open by means of control intervention
- **Functional monitoring ASV:**
Comparison of the control signal with the position feedback signal of the anti-surge valve
- **Changeover of control parameters:**
Control parameters can be switched over jumplessly
- **Adjustment of the control characteristic:**
Adaptation to changed boundary conditions
- **External setpoint pressure limitation:**
Frequently used function in the start-up phase of the process
- **Performance recording:**
Extension of the data recording
- **Reverse-flow protection:**
Surge protection and anti-surge control in API670 design
- **Process control:**
Activation and parameterization of an integrated process control

Versatile Application

The kmo anti-surge control can be used on any turbocompressor, axial and radial, with various process gases, vapor et cetera. kmo controls are successfully in use all over the world. Counted among the customers are both, compressor manufacturers and plant operators.



Competent and approved

kmo turbo is based on decades of experience and offers professional support for failure-free, stable operation:

- Anti-surge control
- Reverse-flow protection
- Centrifugal compressor audit
- Vibration diagnosis and diagnostic systems
- Vibration measurement/monitoring
- Compressed air master control
- Troubleshooting
- Operation optimization
- Commissioning
- Retrofitting

Parameterization

The control system can be intuitively configured and parameterized via the web-based user interface. Both, the current and the stored signal course, can be visualized. All screen views can be saved as PDF files. The special functions can be activated individually. Only the parameters of the activated functions are displayed.

Anti-Surge-Control: PVR_ISH-LT5


[Parameter](#)
[Control-Line](#)
[Valve Charact.](#)
[Archive](#)
[Online Graphics](#)

Parameter

Measuring Point	Tag	DIM	Range from	Range to	Wire break	Alarm active	Value	Max	Channel
V dp-Suction	F4711	mbar	0.0	200.0	-3%	☒	95%		TR1
p1 Suct. pressure	P4712	bar	0.0	2.0	-3%	☒	95%		constant
p2 Disch. pressure	P4713	bar	0.0	10.0	-3%	☒	95%		TR3
Y Y-extern	H4714	%	0.0	100.0	-3%	☒	105%		TR4

Ramp Y-Extern
kp
Map: DV scale MAX

60 sec
1
10

TN
Pressure Limit

20 sec
90 %

TN-Reduction

ON

Reduction
from XD

50 %
-1 %

to XD

-6 %

Dead-Time-Minimizer ASV

ON

with XD

-2 %

Setpoint to ASV

90

Function-Monitoring ASV

Bus

Measuring Point	Tag	DIM	Range from	Range to	Wire break	Alarm active	Value	Max
			0.0	0.0	0%	☐	0%	

Monitoring-Time

5 sec.

Deviation

5 %

Changeover Control-Parameters (Parameter-Set 2)

Bus

Measuring Point	Tag	DIM	Range from	Range to	Wire break	Alarm active	Value	Max
Fördermenge	F 4715	Nm³/h	0.0	0.0	0%	☐	0%	

Switch Point
kp Parameter-Set 2

20 %

Hysteresis
TN Parameter-Set 2 <

2 %
sec.

Temperature Compensation

Bus

Measuring Point	Tag	DIM	Range from	Range to	Wire break	Alarm active	Value	Max
T-Suction	T 4716	°C	0.0	100.0	5%	☐	95%	

Temperature
Variation DV

12 %
10 %

Variation Temperature

10 %

External Setpoint Pressure-Limit

OFF

Recording Current/Power

Bus

Measuring Point	Tag	DIM	Range from	Range to	Wire break	Alarm active	Value	Max
Power	E4715	kW	0.0	3.0	-3%	☐	110%	

Reverse-Flow Protection

OFF

Process-Control

OFF

Date and Time PC

01.12.2017 16:54:43

Date and Time PLC

01.12.2017 16:54:44

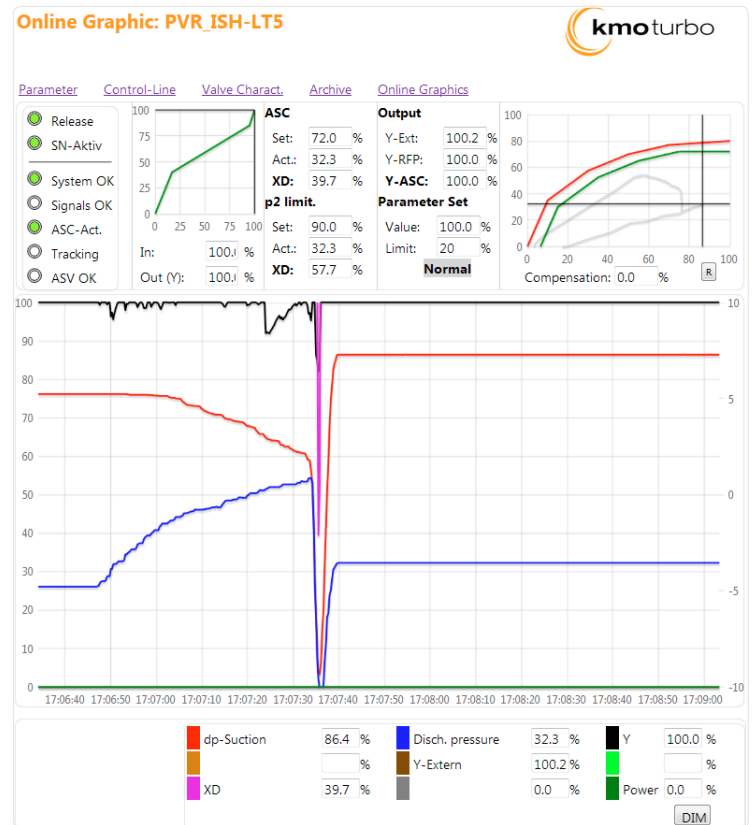
Set

2017-12-01-16:46:18 kmo turbo_KM

write

read

Online Illustration



Practical tool for commissioning and fault analysis; all current signals are displayed numerically as well as graphically over a period of several minutes. The surge limit and the control line are parameterized in a separate mask and are shown at the top right. The cross-hair pointer represents the current operating point. The adjustment of the valve characteristic curve is parameterized in a separate mask and is shown in the online graphic at the top left.

*Unmatched
transparency*

The whole process at a glance

A diagnostic memory is integrated in the anti-surge controller. Activated by the kmo reverse-flow protection or via an external contact, a data storage is triggered (typically: 200 sec pre-event and 200 sec post-event). The current values at the trigger event are stored in a table and the historical data are displayed graphically. Up to 50 events are stored.

The accessible records make it easy to identify the cause of surging. The graphic of the archived events enables a detailed analysis by zooming, using the cursor and export to Excel.

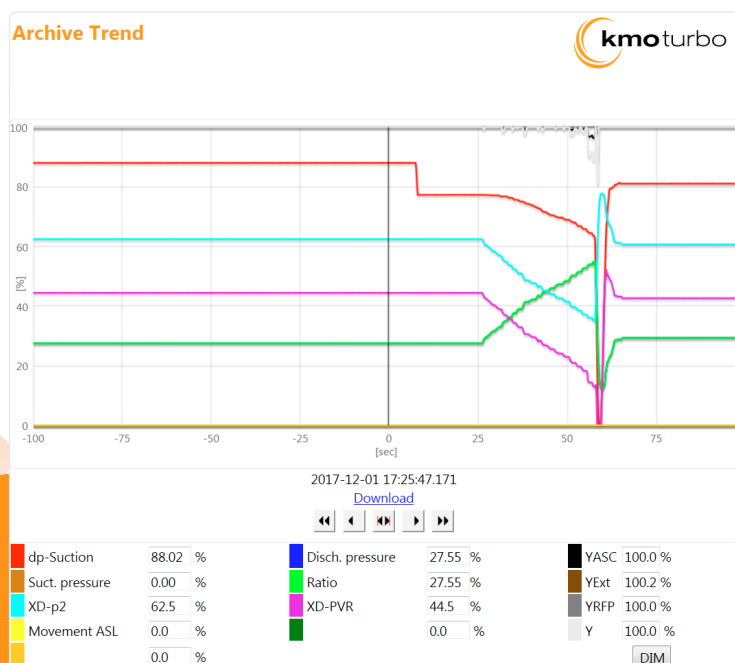
Archive: PVR_ISH-LT5 kmo turbo

Parameter Control-Line Valve Charact. Archive Online Graphics

Values saved 2,0 sek before surging

Date	Flow	p1	p2	DV	XD-p2	XD-PVR	Mov	Leistung	YExt.	Y	
	%	%	%	%	%	%	%	%	%	%	
2017-08-31 10:18:21	73.5	41.1	87.5	77.3	7.5	-5.3	0.0	28.7	100.0	0.0	TREND
2017-08-31 10:32:06	79.9	41.1	87.5	77.3	7.5	-5.3	0.0	28.6	100.0	8.0	TREND
2017-09-04 08:57:20	71.9	52.7	87.5	65.5	7.5	6.5	0.0	0.0	30.2	30.0	TREND
2017-09-04 09:02:39	53.4	60.8	87.5	59.0	7.5	6.6	0.0	0.0	22.3	22.2	TREND
2017-09-04 09:09:07	42.3	60.8	87.5	59.0	7.5	-0.4	0.0	0.0	0.0	0.0	TREND
2017-09-04 13:26:51	63.0	0.0	48.6	48.6	46.4	20.4	0.0	0.0	0.0	0.0	TREND
2017-09-04 13:29:04	84.4	0.0	83.0	83.0	12.0	-11.0	0.0	0.0	0.0	0.0	TREND
2017-10-05 17:51:10	9.6	0.0	31.9	31.9	63.1	-5.7	0.0	0.0	0.0	0.0	TREND
2017-10-20 09:53:55	36.3	0.0	39.9	39.9	55.1	14.9	0.0	0.0	43.8	0.0	TREND
2017-10-20 09:59:03	48.6	0.0	43.9	43.9	51.1	20.0	0.0	0.0	43.8	0.0	TREND
2017-10-20 10:24:12	48.5	0.0	49.4	49.4	45.6	14.5	0.0	0.0	0.0	0.0	TREND
2017-11-21 16:30:30	47.7	0.0	61.1	61.1	33.9	5.9	0.0	0.0	0.0	0.0	TREND
2017-11-24 09:38:09	45.1	0.0	52.4	52.4	42.6	8.8	0.0	0.0	0.0	0.0	TREND
2017-11-27 09:03:21	45.1	0.0	52.5	52.5	42.5	8.7	0.0	0.0	0.0	0.0	TREND
2017-11-27 09:11:18	46.5	0.0	46.5	46.5	48.5	15.1	0.0	0.0	0.0	0.0	TREND
2017-11-27 09:18:17	46.5	46.5	0.5	-12.1	94.5	69.0	4.8	0.0	0.0	0.0	TREND

lesen schreiben löschen DIM



Turbocompressor Audit

Experience has shown that the parameters set during commissioning of a compressor do not provide a long-term guarantee for secure, stable and efficient operation. The initially prevailing conditions may change through time, e.g. due to polluted coolers, measurement drift, wear or failure of individual components et cetera. **kmo turbo** provides a compressor auditing service, recording all relevant values so that an up-to-date compressor map can be created. Clear recommendations of action are given for improvement and optimization of the operation.

Compressors should be equipped with two independent systems: an anti-surge control and a multi-step reverse-flow protection, which can reliably intervene whenever necessary. This allows you to protect both, your compressor and your process.

Your experienced partner for failure-free and stable operation:

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