Up to date actuator technology protects valves

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Industrial valves are often subjected to extreme loads. However, design features in modern actuators literally makes it possible to "go easy on your valves". How about soft starting out of and into the end position which prolongs service life, significantly reduces lifecycle costs and makes time-consuming routine inspections obsolete. This technical paper describes features currently available in a new series of rotary, linear and part-turn actuators, made by SIPOS Aktorik GmbH

SIPOS 2SA5 rotary actuator

SIPOS 2SB5 linear actuator

SIPOS 2SC5 part-turn actuator

Control valves have been on the move ever since they were first invented - and they are still moving today. Yet how these valves can be controlled in an open or closed loop both now and in the future, how their functional reliability can be monitored in the interests of efficient process operation, and how a general high standard of performance and quality can be achieved and maintained is an entirely new chapter. A new series of intelligent actuators provides technology that will benefit all end users of valves.

Electronic components have become standard features of almost every actuator. In many cases they take the place of complex mechanical devices to convert different speeds or sense travel and torque, and they also substitute instrumentation and control switchgear. For some time now, it has been possible to integrate the complete control equipment – including all the communications and power electronics – in the actuator, and in doing so permanently enhance its functionality. Using these actuators thus generates substantial savings, not just in terms of operating costs but also throughout the complete lifetime.

Why every valve needs caressing

Even high-quality valves are often forced to suffer a good beating from many different ambient sources, such as the frequently aggressive medium or constant stress from magnification torques in the end positions. This is especially true when conventional type actuators are used. The outcome can be total failure of the valve without any prior warning if its condition is not monitored regularly by means of cost-intensive routine inspections and if essential maintenance work is neglected.

There is a simple and lasting solution to all of this, however. Namely to furnish actuators with functions that render expensive routine inspections superfluous by instead facilitating demand based inspections. Repairs are in other words only necessary if wear, deposits or corrosion are likely to impair the valve's ability to move freely, or possibly even block it completely, in the foreseeable future.

Technical subtleties to protect the valve

In practice, 'caressing' takes the form of soft starting with a high starting torque out of the end position and soft moving into the end position - without any magnification torque whatsoever. The valve is moved out of and into the end positions with the maximum torque by means of a microcontroller. Soft starting protects the valve, thus considerably extending its service life and improving its availability. These technical subtleties in the electronic control moreover ensure that the starting current is always less than the rated current, so that smaller power line cross-sections are possible compared to other, similar actuators. This provides a tan-

gible cost benefit to users.
SIPOS 5 Flash actuators achieve this thanks to an integrated frequency converter (which modulates the frequency and amplitude) with a motor speed that is automatically reduced in the end positions, even with a 20% voltage drop. There are thus no magnification torques if the valve is blocked between the end positions. The voltage for each of the many available speed/cut-off torque combinations is preselected so that the cut-off torque setting corresponds to the stalling torque of the motor. Even an unscheduled intermediate stop thus does not result in torque damage. The valve moves into the end position softly and safely at low speed and without any magnification torque (Fig. 1). The formula "stalling torque = cut-off torque" still applies, though without the usual magnification torques that are the norm with conventional type actuators.
Our range of actuators offers seven settable speeds in selectable speed ranges. This means the same actuator can be used with different valves and at different speeds. In addition, the PROFITRON version (enhanced functionality) allows an emergency speed to be set in both the OPEN and the CLOSE direction for approaching a selectable emergency position.

Maintenance only when absolutely vital

The term 'ambient sources' covers a very broad spectrum. The same applies to media, loads and valves. Many factors can have a detrimental effect on a valve's functionality and service life. Systematic preventive maintenance is practically impossible, however, because in addition to the medium and the ambient influences mechanical loading would also have to be taken into account. In other words, operating hours, switching cycles and torque-dependent cut-offs – all of which are difficult to measure and control.
The use of transmitters in actuators to supply data for use in maintenance software is becoming more established. For example, the SIPOS 5 Flash PROFITRON is capable of triggering explicit maintenance requests because valve-specific data is self-monitored. A kind of dialog takes place between the user or operator and the actuator, in which the actuator provides information about the timing and nature of necessary valve maintenance.

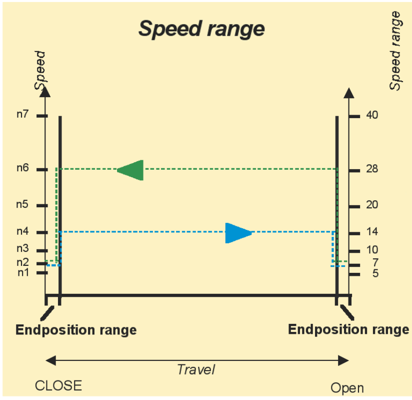

Figure 1. The valve moves softly out of and in to the end positions. This example shows a speed range of 5-40 min^{-1} with 14 min^{-1} in the OPEN direction and 28 min^{-1} in the CLOSE direction

This is made possible by specifying a load-dependent maintenance interval, in other words maintenance limits for switching cycles, torque-dependent cut-offs and motor operating hours. If one of these parameters exceeds a programmable threshold, a maintenance signal is generated and output as a 24 V signal either on the PC or over a fieldbus. After the maintenance work has been carried out, the actuator is notified and the monitoring equipment is fully operational again.

Linearized characteristics permit simpler valves

Expensive special valves are usually indispensable for sensitive processes in order to achieve the right balance between travel and medium flow rate. These devices are used whenever the control process can or must be made more precise, but the control itself has to or should remain relatively simple.
The required relationship between travel and medium flow rate can be obtained just as effectively by altering the positioning speed while opening and closing the valve.
We have provided for optimization of this kind of control process by specifying various travel-dependent speeds for up to ten interpolation points in the form of a clearly defined curve (for the PROFITRON actuator).
The travel-speed interpolation points are set either locally by means of pushbuttons and the display or remotely using COM-SIPOS, the parameterization software for PCs.
This function is referred to as the "travel-speed curve" and is used also to linearize valve characteristics (Fig. 2).

Accurate valve status reports

For years, plant owners and I&C suppliers have been wanting to receive information from an "intelligent" actuator about the torque actually required by the valve. The arguments they put forward are many and varied. They range from demand based maintenance as an alternative to conventional inspections through early detection of valve damage to cause localization in the event of operating problems. Questions such as "is the actuator producing enough torque?", "does the valve need too much torque?" or "is the valve still moving freely?" tend to be heard again and again.
A recordable torque curve over the full travel was one of the specifications for the actuators installed in RWE's Niederaußem large-scale lignite power plant project (Fig. 3).
This function is an integral part of the maintenance concept for optimizing the power

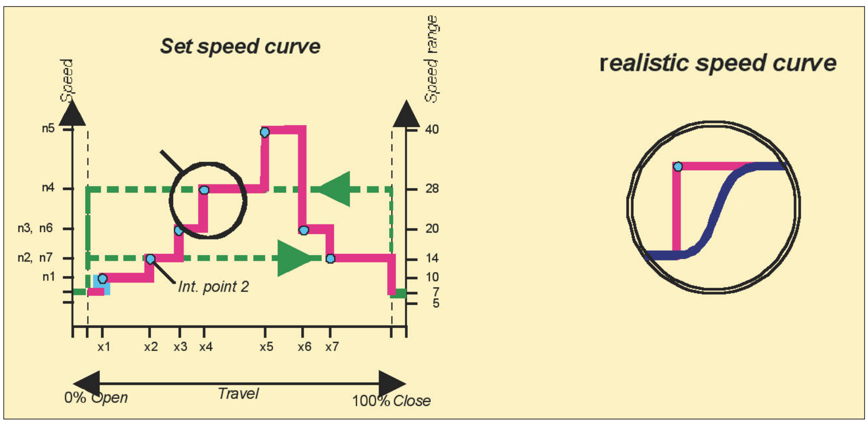

Figure 2. Linearization of valve characteristics: Owing to the inertia of the actuator and the valve, the stair-step curve of the travel-speed interpolation points yields a smooth speed curve, which can be additionally adapted by altering the similarly parameterizable ramp-up time

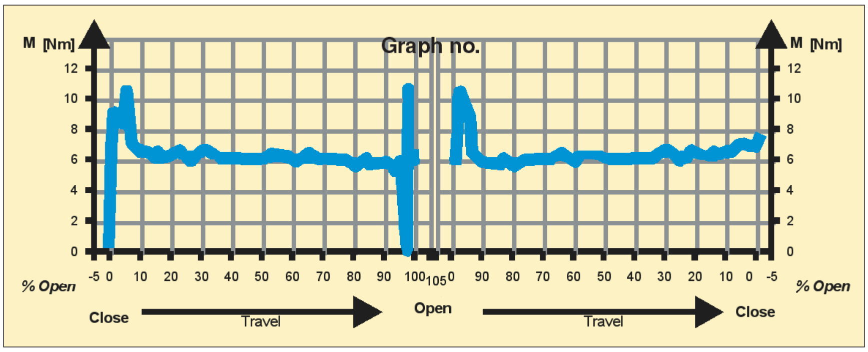

Figure 3. Torque curve of a valve

plant's availability while simultaneously restricting human resource requirements to a minimum.

The evolution of the PROFITRON enabled the necessary electronic hardware resources, such as computational power and storage capacity, to be realized.

Up to three torque curves can be stored and read out on a PC using standard software (such as Excel) after the data has been transferred there with the help of the PC parameterization program. The sampling rate increments correspond to 1% of the travel. Each torque curve is freely selectable and can be overwritten if required, as the Niederaußem project (approx. 1000 SIPOS 5 actuators) demonstrates: graph 1 without a process medium after the end positions have been set by the valve manufacturer; graph 2 after installation in the pipeline; graph 3 when the plant was commissioned and thereafter cyclically throughout the plant life.

The torque curve recording can be started locally with actuator push-buttons, by COM-SIPOS or - if the actuator is equipped optionally with "PROFIBUS DP" - by means of the advanced utilities of the DP protocol (DP-V1 utilities) in "acyclic" mode. The latter method is used, for instance, by SIMATIC PDM (Process Device Manager), a parameterization and diagnosis software. The torque curve which is produced for linear and part-turn actuators is proportional to the actual force curve of the linear actuator or the torque curve of the part-turn actuator.

Analog speed control reduces switching cycles

Typically, SIPOS actuators offers separate speeds for opening or closing direction. It is also possible to set one emergency speed for each direction that can be resorted to whenever changes or disturbances occur in the process - before they escalate to a "proper" fault. The speed of the actuator therefore has to be selected in advance if a conventional actuator is used. This is often very

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tricky, however, especially when designing installations for local authorities (water, sewage, pressure etc.), because in many cases it is impossible to accurately assess the influencing quantities. Major modification work is usually unavoidable if the selected speed needs to be subsequently altered.

Even imprecise control necessitates many complicated readjustments to align the setpoint and the actual value exactly.

SIPOS 5 actuators, which have always allowed one out of seven possible speeds in a selected speed range to be set or parameterized at any time, overcome this problem completely.

In view of the growing demand for more and more precise processes with improved control characteristics, actuators too are obliged to respond sensitively to small changes detected by means of sensors. Minimal deviations between the setpoint and the actual value can only be corrected at low speeds.

Thanks to the "analog speed setpoint" function, PROFITRON actuators can be used at different speeds without having to interrupt operation in order to reparameterize. The speed is selected by means of a 0/4 to 20 mA signal at the actuator's second analog input.

In addition to finer control, this offers several other useful advantages:

- A low current value, in other words a low speed, enables,pressure surges in the pipeline to be effectively prevented when a valve is being closed.
- The risk of cavitation, when the flow velocity of the medium increases as a function of pressure can be practically eliminated with a high current value, in other words at maximum speed. The pipe and the valve are thus better protected against extreme loads and wear.

But what goes on in the actuator electronics? The setpoint signal is first smoothed before being converted with hysteresis to one of the seven speed steps. The decision to im-

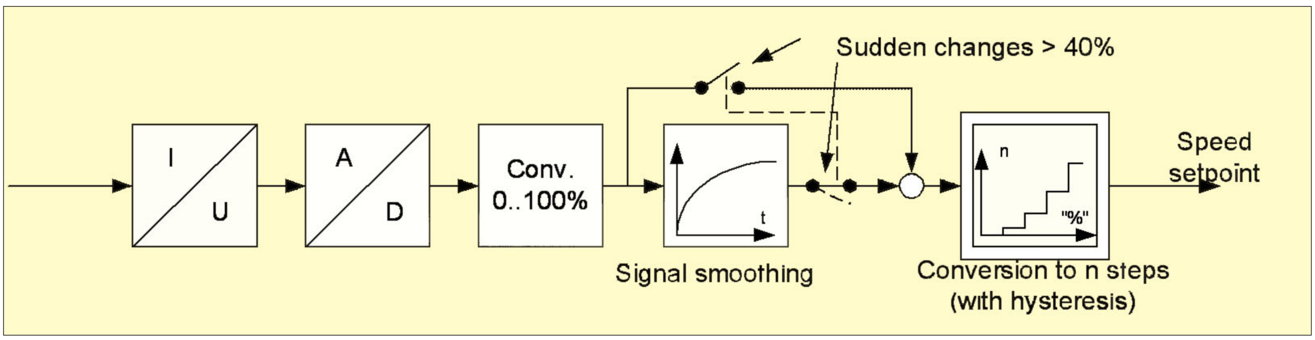

Figure 4. Signal route for generating the speed setpoint

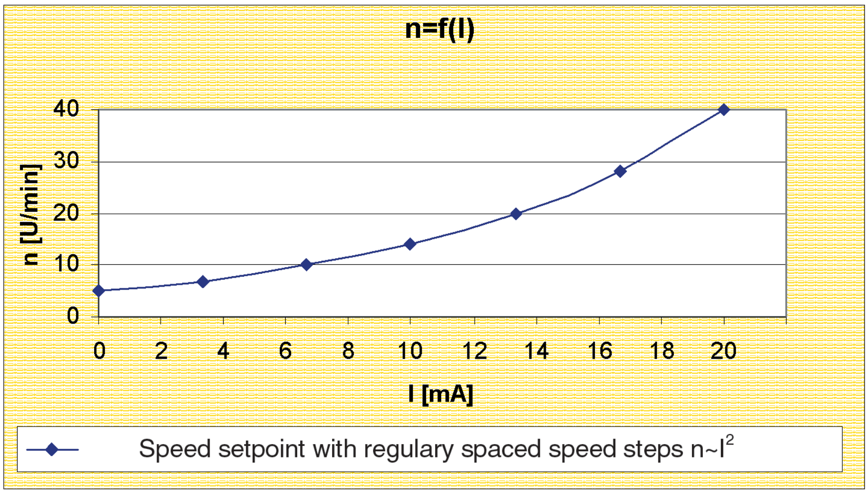

Figure 5. The current setpoint (here: 0 ... 20 mA) is converted to a speed setpoint (here: 5 ... 40 min-1)

plement speed steps rather than allow the speed to be adjusted continuously has the advantage that the torque continues to be evaluated in the same way (current thresholds at the actual operating point, as defined by the speed and the set cut-off torque in the actual direction of rotation). The steps provided for these actuators (e.g. 5 min-1, 7 min-1, 10 min-1 etc.) normally prove sufficiently fine in practice (Fig. 4).

The analog current value is converted to a speed with regular steps; the non-linear speed steps of the SIPOS 5 ($n_i = n_{i-1} * \sqrt{2}$) result in a non-linear relationship between the current setpoint and the speed (Fig. 5):

Conclusion

Advances in electronics offer significant advantages to plant owners. The integration of intelligent functions in actuators means users can benefit, for example, from feedback about the valve's function and flagging of potential problems as well as from variable speed control of the valve movement for superior flow control. ■

About the authors

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