Application Description
AG/TZIDC_101-EN

Efficient Fast Closing of Shutoff Valves with "Non-linear" Characteristic Curve

Using Positioners to Achieve a Controlled Limited Pressure Increase in Pipes

Instrumentation Solutions

- Universal digital positioner for various applications
- Robust technology, proven for many years
- Enhanced product features with Rev. 3.00

ABB Instrumentation

1 The Problem

Butterfly valves, ball valves and plug valves are frequently used as shutoff valves since they produce only negligible pressure losses, and thus energy losses, when fully opened. This is an important aspect in times of rising energy costs.

These types of valves typically have a flow characteristic where the flow reacts to small positioning steps with overproportionally large flow variations in the range of small flow cross sections.

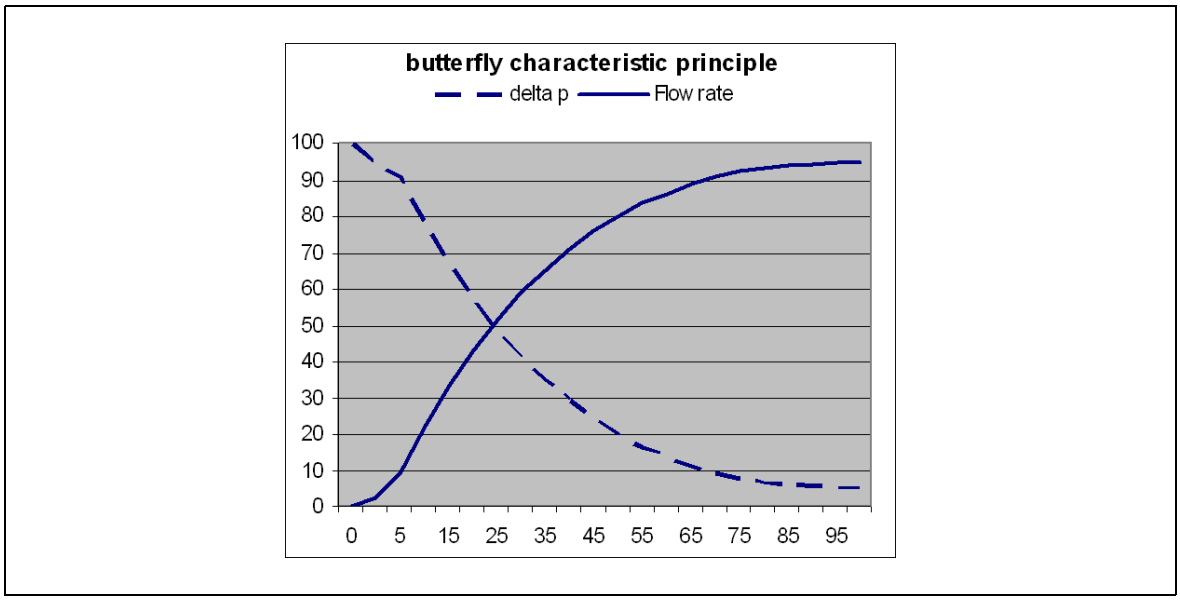

Figure 1-1:Equal percentage valve characteristics

This behavior is reversed in the range of large flow cross sections, which means that even large positioning steps, and thus large variations of the cross section, will cause comparatively marginal flow variations. A typical example for this are valves with equal percentage characteristics where a defined positioning step results in a defined percentage variation of the cross section. Figure 1-1 shows the flow characteristic and the corresponding pressure of a valve with equal percentage characteristic.

For plants where large mass flows have to be controlled, this behaviour during the closing of the valve is very problematic due to the inertia and the energy stored in it. In worst case, uncontrolled closing can cause a water hammer, i.e. a pressure peak which may lead to overstraining or even to the destruction of the valve. Pipe implosions can also be caused as a result of the vacuum which may occur upstream the valve due to the unretarded continued mass flow.

Really critical are output ranges < 15 % where almost 50% of the mass flow has to be retarded with less than a fifth of the open cross section.

It is state of the art to close pipes, flanges and valves that are subject to water hammer in a controlled way using special mechanical-pneumatic devices or electric actuators, involving the use of additional pipe protection devices.

The ABB Positioner TZIDC Rev. 2.00 already offered a suitable way for the controlled, slow closing of such critical valves by means of a configurable setpoint ramp which internally converts step changes of the setpoint to an elongated linear setpoint variation. Since the setpoint ramp function also increases the stroking speed in output ranges without critical flow change, and thus pressure change, the secure closing in TZIDC Rev. 2.00 was however traded off for an unnecessarily long closing time.

2 The Solution

The new version of the ABB Positioner TZIDC Rev. 3.00 now allows the combination of setpoint ramp with an output characteristic. This type of setpoint processing is not state of the art for 4 … 20 mA devices.

The described combination allows a fast positioning of the valve in output ranges with uncritical pressure increase, combined with positioning in a manner which controls the pressure increase in the "critical" output ranges.

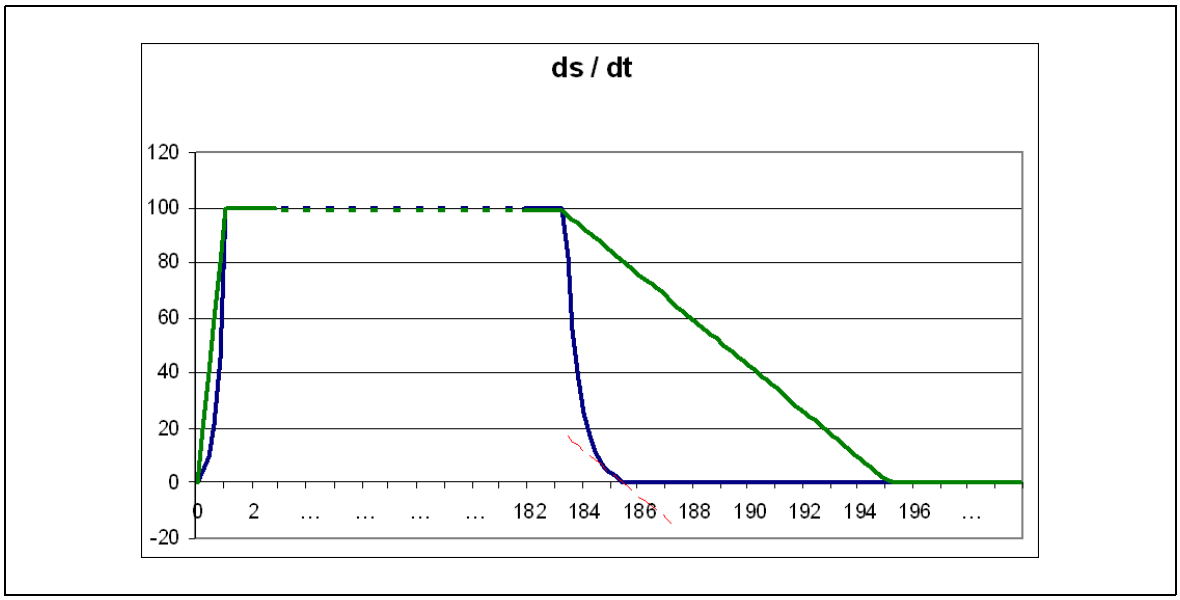

Figure 2-1:Comparison of closing curves TZIDC Rev 2.00 (green) and Rev. 3.00 (blue)

Figure 2-1 compares the output behavior of TZIDC Rev. 2.00 (green curve) with the output behavior of TZIDC Rev. 3.00 (blue curve). The red support curve indicates the travel speed with TZIDC Rev. 3.00 for an opening cross section of 12 %.

This illustrates that in spite of the closing time which is reduced by factors, the stroking speed of the TZIDC Rev. 3.00 is lower than the stroking speed of the TZIDC Rev. 2.00 in the area of the critical pressure increase.

This means that without any disadvantageous effect on the opening time of a valve, TZIDC Rev. 3.00 allows a faster closing while the water hammer risk is clearly reduced.

No expensive analog output of a control unit is required to use this function. Fed by a constant current source 3.8 ... 4 mA, the standard digital input can be used to achieve the valve positions 'OPEN' and 'CLOSED'.

The new revision again offers several possibilities to feed back the output signal, ranging from the optical position indicator to the retrofittable plug-in module for analog feedback of the current position up to redundantly fed limit and proximity switches.

3 Customer Benefit

So far, complex and thus expensive mechanical and pneumatic devices are being used to ensure a controlled secure closing of shutoff valves with equal percentage characteristic.This function is now simply and efficiently realized via the digital positioner TZIDC[1)]. In addition, it integrates several options for the feedback of the current position, independently fed if required. These functions otherwise have to be procured, installed, calibrated and maintained separately.

[1)] The functions described in this document are realized using microcontrollers. An uninterruptible power supply is therefore required to ensure permanent availability.

4 Features of the Components Utilized

Instrumentation

Digital positioner TZIDC / TZIDC-200

- Worldwide proven IP signal converter
  - Nozzle-flapper converter principle
  - Unmatched ruggedness against shock and vibrations
- Wide operating temperature range from 40 … 85 °C
- Low air consumption of 0.03 kg/h, independent of supply pressure
- Extremely high accuracy:
- The optimized positioning algorithm acts like a servo drive, extremely fast, accurate and with long-term stability
- Extensive diagnostic features:
  e.g.: Load determination, leakage monitoring, valve diagnosis, hardware malfunction
- Autoadjustment saves time and money
  - No manual entries required
  - No mechanical range adaptation
  - Automatic determination of all parameters
  - Increased adjustment accuracy
  - Separate sets of parameters for opening and closing
- Powerful local control

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