The sliding gate valve reins in costs for steam systems

Rapid control dynamics reduce steam consumption by up to 30 %

An application report by Dr. Rainer Lange and Peter Stein

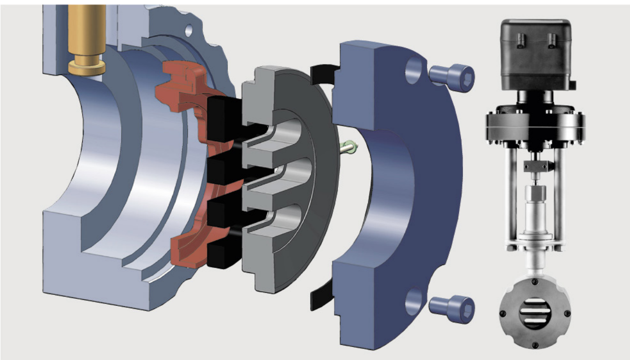
The level of quality attainable in controlling a steam plant is heavily dependent on the dynamic characteristics of the total system comprising the control element, actuator and controller. The control parameters for sliding gate valves relating to dynamic behaviour are clearly superior to those for conventional control valves. As a result, the highly responsive dynamics not only improve the control quality but also form the basis for control circuits with very short reaction times. This has proved to be the key factor in steam savings of up to 30 %. Current comparisons of steam plant operators show that savings of this magnitude are attainable only by installing a sliding gate valve in place of a traditional control valve.

The most important prerequisites for short reaction times in a control element are short strokes, small actuators and low actuation forces resulting from these. All of these characteristics come together in the sliding gate valve. As it operates, two slotted plates slide against each other transversely to the direction of flow. Thus, the sliding gate valve seals itself without the need for a metallic seat. The typical stroke between opened and closed is a mere 6 to 9 mm. One of the most noteworthy advantages stemming from this operating principle is the low actuation force required for the positioning movements.

This actuation force F can be determined for the sliding gate valve by the coefficient of friction μ of the sliding pair, the slot area A_{Slot} facing the flow and the differential pressure Δp with $F1 = \mu A_{Slot} \Delta p$. The force requirement for an equivalent globe style valve is obtained from $F2 = A_{Seat} \Delta p$. Comparing these two forces mathematically results in $F1 / F2 = \mu A_{Slot} / A_{Seat} = 0.1$ for valves with the same K_{vs} value and the same differential pressure. Therefore, the sliding gate valve needs only one tenth of the actuation force required by a globe style valve under the same process conditions. Also as a direct result of this, the valve actuator for sliding gate valves is naturally correspondingly lighter and smaller.

Control dynamics at the highest performance level

By analysing its frequency response, the dynamics of a control valve can be evaluated in terms of its control performance. This



The high control quality of sliding gate valves form the basis for control circuits with very short reaction times. This proves to be the key factor in steam savings of up to 30 %.

aspect was studied experimentally, for example, in [1] for different control valve systems. The general conclusion which can be gathered from this is that the use of sliding gate valves in a control circuit results in higher critical gains. On the one hand, therefore, the process controller can be set “more aggressively”, while, on the other hand, overshooting is reduced when approaching a changed set point value, which is also reached more quickly.

Depending on the plant and process, it is therefore possible to tap into potential additional savings simply by exchanging a globe style valve by a sliding gate valve. By doing so, the quantities of steam fed unnecessarily into the system by an overshooting action are reduced. This is supported by the figures recorded by operators of different steam systems.

Chinese Tobacco manufacturer, Hongta Tobacco, reduces steam consumption by 30 %

In the three lines at the Chinese tobacco manufacturer, Hongta Tobacco, the tobacco is conditioned at different temperatures. The process variable defining the quality is the temperature setting at 60, 65 or 70 °C. Depending on the temperature setting required, previously Hongta Tobacco had required up to 990 kg of steam per hour for this process. The plant operator replaced traditional globe style valves in this steam facility - without making any other changes to the plant - with sliding gate valves. Then the temperature control parameters were readjusted and the resulting steam consumption measured with the following remarkable results. Afterwards, the steam consumption fell in the

- 60 degree line by 200 kg/h, or 36 %,
- 65 degree line by 200 kg/h, or 25 % and
- 70 degree line by 150 kg/h, or 17 %.

The investment in the sliding gate valves had payed off within a matter of a few months.

Palm oil producer Palmaju Edible Oil saves 5 tons of steam per day

Besides the advantages that sliding gate valves can bring to systems, they are also easy to automate. The potential savings that can be achieved from a sliding gate valve incorporating an intelligent positioner are impressively documented by the operator of a palm oil plant, Palmaju Edible Oil, in Johor, Malaysia. By using a small sliding gate valve with a nominal size of DN32 with a digital positioner instead of a self acting pressure regulator, Palmaju Edible Oil was able to reduce the steam consumption by 5 tons per day. Based on the energy generating costs in Malaysia the savings potential amounts to over 25,000 euros per year for the plant operator by using this single valve.

With integrated process controller

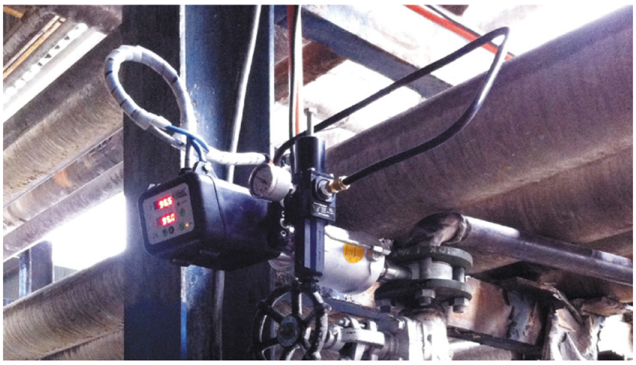
As an option, the 8049 positioner used here has an integrated process controller for local control tasks. This version of the positioner with an IPC process controller combines the function of a positioner with that of a process controller. Thus, it is possible to set up local control circuits as found commonly in steam circuits, with minimum cost and effort involved in installation.

The sensor for the process variable - one pressure sensor is sufficient for maintaining the pressure - is connected directly to the controller on the valve and the adjustments needed are carried out on location using a keyboard with a display or with the “DeviceConfig” configuration software. Due to the excellent control quality, the digital positioner which controls the sliding gate valve pays-off within a few weeks in steam systems. By minimising the work required for installation and cabling, converting from manually-controlled valves to automated valves can be achieved extremely smooth.

Short stroke means less wear

In the sliding plate principle with its surface seal formed by the plates in the throttling element, the pressure of the medium against the moving valve plate assists the sealing function of the valve. This functional principle produces a self-lapping effect by the moving valve plate. This seal between the plates is therefore significantly less prone to fail and leakage rates of less than 0.0001 % of the K_{vs}-value are achieved.

In addition, the slotted plates suffer hardly any wear as they slide against each other so that these valves combine long service lives with a high level of enduring leak tightness, even under the severe conditions they face in steam systems, for example. As an option, sliding gate plates are also available in carbon, so that an excellent seal is assured even at very high temperatures with a hard/soft combination of materials. The very short stroke is also



Palm oil producer, Palmaju Edible Oil, saves 5 tons of steam per day by using sliding gate valves.

a factor in service life: short motion paths and switching times protect the packing and the actuator. In the sliding gate valve, both are subject to substantially lower loads. Even after many years, many sliding gate valves reveal no traces of wear either on the diaphragm or in the packing area. The body length of sliding gate valves is extremely short so that they fit easily between two flanges and are easy to handle - including its actuator a DN 150 weighs no more than 15 kg. So it only takes one person for removal, installation and maintenance. Sliding gate valves are available in sizes DN 15 to DN 250 for pressures up to PN 160 and media temperatures from - 200 °C to + max. 530 °C.

References: [1] Lange, R.: Dynamisches Verhalten von Stellventilen, Industriearmaturen Jahrgang 8, Heft 2, Vulkan-Verlag Essen, 2000 [Lange, R.: „Dynamic Behaviour of Control Valves, Industrial Fittings“, Volume 8, No. 2, Vulkan-Verlag Essen, 2000]

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