Getting into position

Use of independent position transmitters can improve the performance of a control loop over time and give early warning of deteriorating control valve performance

Position transmitters are used to monitor the position of modulating control valves or the opening and closing characteristics of critical isolating valves. The information from the transmitter can then be used to diagnose valve performance in order to warn of the requirement for early preventative maintenance or to automatically adjust various control parameters in the positioner or controller. The ultimate objective is to improve process quality and increase plant throughput. Deteriorating valve performance can also lead to environmentally damaging fugitive emissions.

Closed control loops will try to compensate for deteriorating valve performance, but eventually it will be impossible to maintain a given set point. Backlash in mechanical linkages and stiction in valve glands and seats can be detected by tracing the valves' response to a changing input signal. The trace of the valves' actual position relative to a steadily increasing input signal can be recorded when the valve is new, and then compared to other movement traces recorded throughout its life. It is also possible to check that a control valve has been sized properly when first installed. For example, if a valve spends most of its time close to the fully open or fully closed positions, it is likely that it is too large or too small and control will be compromised.

Speed of response, hunting, or overshoot can also be monitored with a position transmitter. If a control valve responds to a signal change too slowly, hunts, or overshoots the desired position significantly before settling into control, then process quality and overall system performance will suffer. Signal increments need to be greater than those used when testing for backlash or stiction. Speed, hunting, and overshoot problems could imply air leakage, incorrect actuator sizing, or inappropriate positioner gain settings.

It is also possible to use the position transmitter to trace valve position against flow rate. A control valve can continue to function well without backlash, stiction, actuator, or positioner problems, but gradual wear of the plug and seat in the valve or a build-up of deposits in the valve or surrounding pipework can affect performance of the control loop.

Similar movement traces can be produced for critical isolating valves. Limit switches can confirm that the desired position has been reached but a position transmitter can determine if the valve is moving smoothly or hesitating somewhere in mid-travel.

Limit switches can also be fitted in a position transmitter. A valve will no longer control when it is fully open or closed, although the control loop will keep trying. This can cause the control algorithm to 'wind-up'. This in turn can cause the valve to oscillate for a while even when the process variable returns to the controllable range. Some controllers can adjust the algorithm to eliminate control wind-up when end of travel is detected via the limit switches.

Types of position transmitters

There are a number of different types of position transmitters. The simplest is a potentiometer driven from the actuator via a gear set. A voltage is applied across the varying resistance of the potentiometer and the resultant current is measured to determine valve position. The potentiometer can be gear-driven through a clutch drive system, which prevents damage to the potentiometer and gears through over travel of the input shaft. Limit stops are provided within the drive to ensure the wiper in the potentiometer remains within the limits of electrical rotation. The range of resistive output will be a ratio of the mechanical rotation to the electrical rotation.

Temperature and the length of the interconnecting cable can affect the resistance of the device. For this reason, it is recommended the potentiometer be used as a voltage divider to eliminate the effects of these fluctuations. To avoid the effects of ambient electrical disturbance, screened cables are recommended when connecting the potentiometer to the associated equipment.

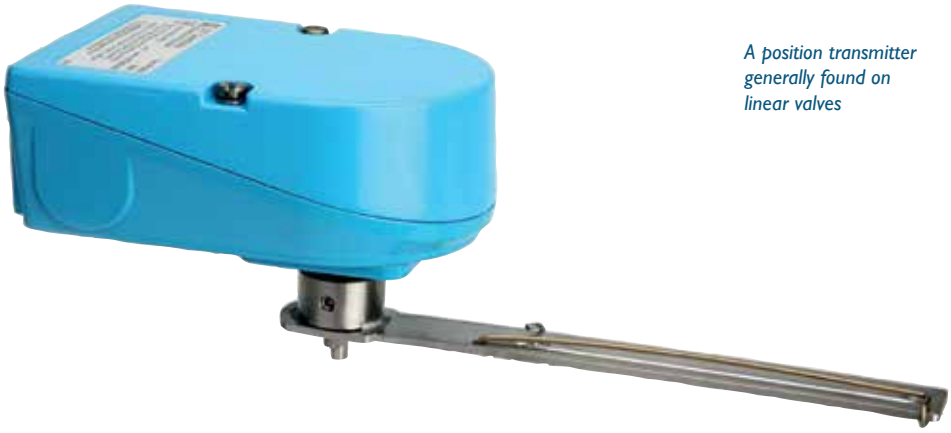
When adapting to linear applications, lever arm linkage systems are often used.

A position transmitter for quarter-turn valves

This conversion from linear to rotary motion will have some effect on the linearity of the device, but this rarely has any practical impact on the performance of a control loop. Backlash in the mechanism can be limited by including a spring within the lever arm that reduces the tolerances in the linkage. Alternatively, a rack and pinion can be used to convert linear to rotary motion.

Linear and rotary variable differential transformers (LVDT/RVDT) can be used in place of potentiometers. They are accurate and – as they do not have contacting surfaces – they are not affected by vibration. However, they tend to be expensive and difficult to adapt from one application to another.

An 'optical encoder'-driven transmitter senses the valve position optically via an LED shining through a slotted disk. Output from such a device is rarely affected by vibration or temperature, but they are expensive, consume a lot of power, and do not give instantaneous output values. Condensation on the disk at low temperatures can also be a problem. 'Hall effect' transmitters are based on a magnetic coupling, and their accuracy is variable. They do not have contacting surfaces, so there is little if any wear due to vibration.



A position transmitter generally found on linear valves

Transducer circuits

The addition of a resistance-to-current transducer circuit in the enclosure with the potentiometer can overcome many of the problems associated with varying lengths of interconnecting cable. The transducer is powered entirely from a two-wire current loop and will generate a 4-20mA signal that will vary with changing valve position. A standard twisted pair of wires is all that is required and the signal is relatively immune to noise. The 4-20mA signal can be matched to the open and closed positions of the valve by adjusting the 'zero' and 'range' settings on the transducer. Some versions allow this to be done by simply pushing and holding a button at each end of travel.

As mentioned earlier, conversion from linear to rotary motion will have some effect on the linearity of the device. Some 4-20mA transducers can be programmed for linearisation. Resistance can be plotted against valve travel during calibration. Once programmed for a given linkage geometry, the same polynomial can be used for different transmitters on valves with the same physical characteristic.

A resistance-to-current transducer circuit with a built-in highway addressable remote transducer (HART) facility permits data acquisition or transmission to and from the position transmitter. This is very useful for remote monitoring or calibration. Digital data is transmitted by superimposing it on top of the 4-20mA analogue signal.

Calibrating the positioners

A hand-held HART calibrator can be connected to the cable at any point between the position transmitter and the control room. The device can then be used to remotely calibrate the ends of travel and also input the date of calibration and valve tag number. The same device can be used to read valve position, calibration date, and tag number from the position transmitter. This can be particularly useful if the position transmitter is located in a hazardous or physically inaccessible location. Ex-certified versions of the handheld calibrator are available for use in hazardous areas.

Transducers that operate entirely digitally and use the Profibus or Foundation Fieldbus protocols are now available. These offer similar benefits to HART, plus the possibility of multi-dropping a number of position transmitters on a single fieldbus spur.

Some electro-pneumatic positioners are available with integrated position transmitters, although sometimes there is a preference for a separate unit driven by a separate linkage on the other side of the linear actuator yoke. This would enable the position transmitter to detect a failure in the positioner linkage or a failure of the positioner's integrated position feedback system.

Some 'smart' positioners have built in software that monitors various actuator and positioner parameters and selects an appropriate algorithm to optimise performance. Foundation Fieldbus smart positioners are capable of local control (via internal function blocks), which releases the remote controller to perform other functions. If Fieldbus smart positioners are fitted to a control valve from the same manufacturer, they are often programmed with detailed information about the characteristics of the valve itself. This can give better local control performance than a positioner sourced from a third party.

Even control valves fitted with smart positioners can benefit from a separate position transmitter. There can be concerns about using a device which is purely software-based to provide position feedback but the use of an independent position transmitter provides a more robust indication of valve position and also can detect a positioner or linkage failure.

Position transmitters can be engineered for hazardous and or hostile environments. Carbon steel, coated aluminium, or stainless steel enclosures for safe area use or with hazardous area approvals are available for surface or subsea use.

In summary, electro-pneumatic positioners, pneumatic positioners, or control valves operated directly via I-to-P converters can all benefit from the data provided to a remote controller by a position transmitter to both improve the performance of the control loop over time and give early warning of deteriorating control valve performance.

For more information:
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