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CALIBRATION OF CONTROL VALVE

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ABSTRACT

Control Valves are meant to control the process parameters namely Pressure, Flow, Level and Temperature. Control Valve is the final control element in any closed-loop control. Based on their application type they are named as Pressure Control Valve, Level Control Valve, and Temperature Control Valve. Calibration is the quantitative determination of errors of a measuring device and, where necessary, adjusting these errors to a minimum. The error is comparison with higher standard having traceability to National or International standard.

I. INTRODUCTION

Reliability and performance of the valve increases, Regular calibration increases the accuracy of operation, Calibrated instruments insures quality products, Unnecessary back jobs may occur frequently due to Out Of Tolerance instruments., Advanced diagnostics is possible, Increases the safety of plant operation, Due to calibration failure rate is reduced, Unnecessary reworks can be reduced"

What is calibration?

In measurement technology calibration is the process of checking the instrument with a standard instrument to improve the measuring functions. The accuracy of standard device taken for calibration should be 10 times the accuracy of measuring device.

What is control valve?

Control valve is used to monitor the flow of fluid by changing the flow passage by the control signal. Pressure, temperature and liquid level are the important process quantities in control system. Control valve allows the direct control of flow rate of these process quantities. The most important final control element in a closed loop system is control valve. There are different types of control valves used .The two basic types are Rotary and Linear (sliding stem motion) valves. Based on the type of control valve used, calibration is done. Manual calibration and Auto calibration are the two common types of control valve calibration. Control valve as an actuator in a control loop operation has an important role in the whole process.

What are the types of Control Valve?

There are a large variety of control valves available to satisfy the process operation needs. Start or stop flow, regulate or throttle flow, preventing back-flow, regulating pressure on fluid or gaseous flow etc are the duties of control valve in a plant operation. The common types of control valves are as follows,

- Ball valve
- Butterfly valve
- Gate valve
- Check valve
- Globe valve
- Diaphragm valve
- Plug valve

What are the main parts of control valve?

The parts of control valve is mainly classified into Body part and Actuator part.

- Valve body
- Valve bonnet
- Valve trim
- Disk and seat

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- Stem
- Valve actuator
- Valve packing

How to calibrate control valve?

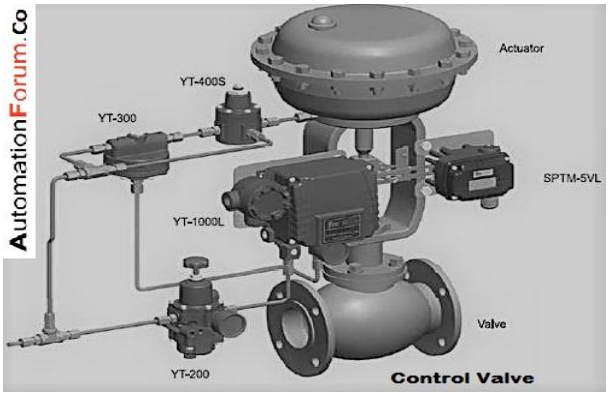

Figure 1: Calibrate control valve

II. REQUIRED MATERIAL

- **Data sheet**
- **Portable pneumatic calibrator**

III. PROCEDURE

- First step is to ask the panel man to put the controller in manual mode for control loop.
- Isolate the control valve from the process(It should be done by a field operator)
- Check the input signal range that is 0.2 to 1.0 Kg /cm2.
- Then calculate the span. That is the difference between higher limit to lower limit (1.0-0.2=0.8).
- Now divide that into four equal parts as 0.2 is the 25% of the span.
- Check the valve travel according to the given input signals.
- Now divide that into 4 equal parts that is 25% (0.5 inch for 0.2 inch valve travel).
- Now increase the span value to 0.2. That is 0.2+0.2=0.4 Kg/cm2.
- Check the valve travel whether it is 25% (0.5 inch). If it is not, then there will be error.
- Now apply full value 1 Kg/cm2 to get the complete travel 2 inch.
- As said earlier if any difference in the readings are found, adjust the spring accordingly.

Table 1: The below table shows the process in detail.

Input percentage (%)	Output pressure Kg/cm2	Stem travel
0	0.2	0
25	0.4	0.5
50	0.6	1
75	0.8	1.5
100	1	2

- After the completion of calibration process ask the panel operator to put the loops in normal mode.
- Now fill the calibration form and it can be used for future reference.

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How to Calibrate Control Valve Positioner?

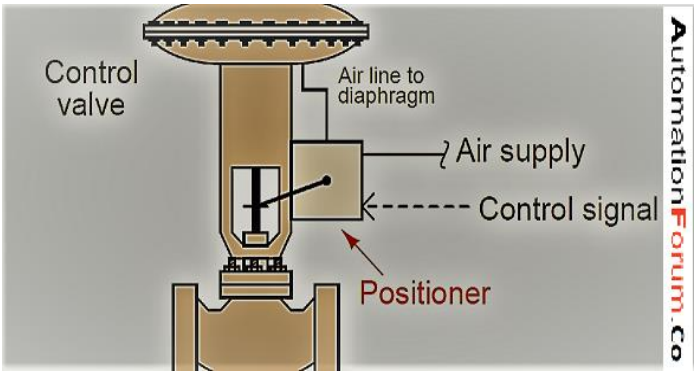

Figure 2: Control Valve

The figure shows the positioner of a control valve. Before calibrating the positioner of control valve, we have to familiar with all components of the instrument and required safety measures should be taken. We have to make sure that the pressure level of air supply is at required level that is at 3-15 psi for almost all cases. Check whether the valve is positioned properly. The valve position is recorded at each test point. For calibrating the valve positioner separately, an input test pressure regulator or hand pump is connected and the applied pressure is monitored with a standard pressure. If supply air is not available, connect the required supply air to the positioner of control valve. The zero adjustment is done with the nozzle pin and by moving flapper adjustment, span adjustment is done.

For a pneumatic control valve, the calibration process is manual.

- Make sure that we have the right cam for the positioner and is installed properly.
- Next we need to check the feedback arm.
- Keep the valve in 50 percent of the range when mounting the positioner.
- Check whether the air supply is enough to work.
- Check whether the positioner output is connected to valve actuator.
- To begin calibration the operation, need to supply 4 milliamps to set the zero position.
- Supply 20 milliamps and using the flapper adjust the span.
- Check zero when span adjustment is finished and repeat the process until we have the correct travel.
- Next ramp up and down the valve's travel using 4, 8, 12, 16 and 20 milliamps.

Thus the calibrating process of pneumatic control valve is over.

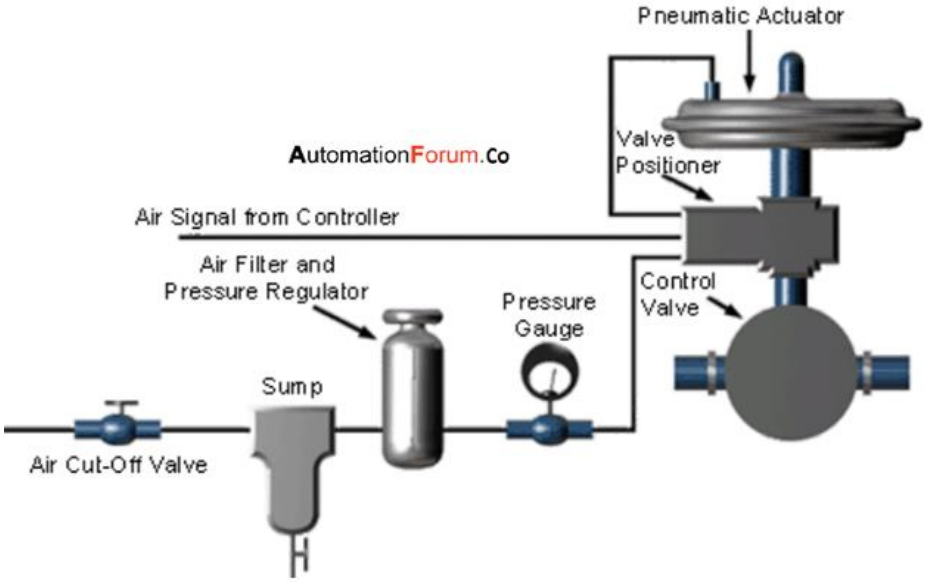

Figure 3: Pneumatic valve and what is the function of pneumatic valve

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A measuring device instrument should be calibrated based on the recommendation of the manufacturer. It should be calibrated periodically, that is annually, quarterly or monthly. In a process plant operation, Mechanical or electrical shock may happen to measuring instrument, calibration should be done immediately after any such kind of incident occurs. When compared with the cost of calibration, hidden costs and risks associated with the uncalibrated device is high, which adversely effects the plant operation. So it is better to calibrate the instrument at regular intervals to reduce the error and to increase the accuracy of measurements.

What are control valve calibration standards?

Various standards are applicable to control valves. For companies that participate in global markets, international and global standards are important. Following are the list of codes that is important in design and application of control valves.

- **API (American Petroleum Institute).**
- **ASME (American Society of Mechanical Engineers).**
- **SEN (European Committee for Standardization.**

1. **European Industrial Valve Standards.**
2. **European Material Standards.**
3. **European Flange Standards.**

- **FCI (Fluid Control Institutes).**
- **ISA (Instrument Society of America.**
- **IEC (International** Electro technical **Commission).**
- **MSS (Manufacturers Standardization Society).**
- **NACE International.**

What are errors in control valve calibration?

Calibration is the process of comparing the instrument with a known instrument value, which is standard, error will be there. An error is the difference between the actual algebraic value and indicated value. Error analysis is an integral part of the process.

1. **Zero shift calibration error:**

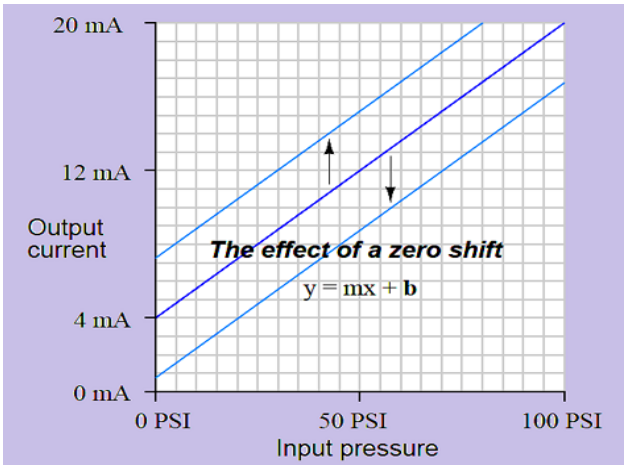

Figure 4: Zero shift calibration error

Consider the slope intercept equation **y=mx+c**

- y= output
- m= span adjustment
- x=input
- c=span adjustment

A zero shift calibration error affects all calibration points equally. Consider the pressure transmitter with 0 to 100 PSI input range and 4 to 20 mA output range. This error may be corrected by moving the zero adjustment.

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2. Span shift calibration error:

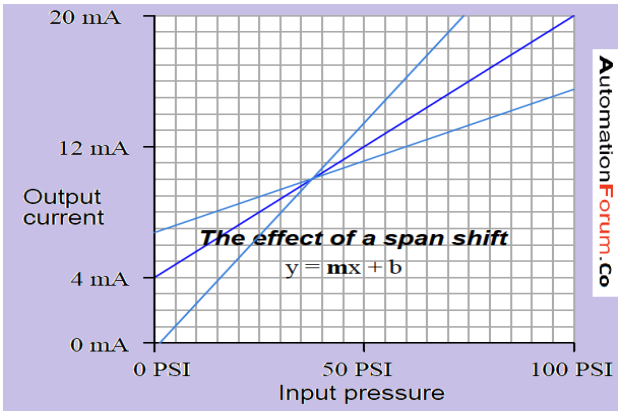

Figure 5: Span shift calibration error:

This error shift the slope of the function. The effect is unequal at different points throughout the range. Span shift error may be corrected by adjusting the span, until it is ideal, essentially by adjusting the value of m in linear equation.

3. Linearity calibration error:

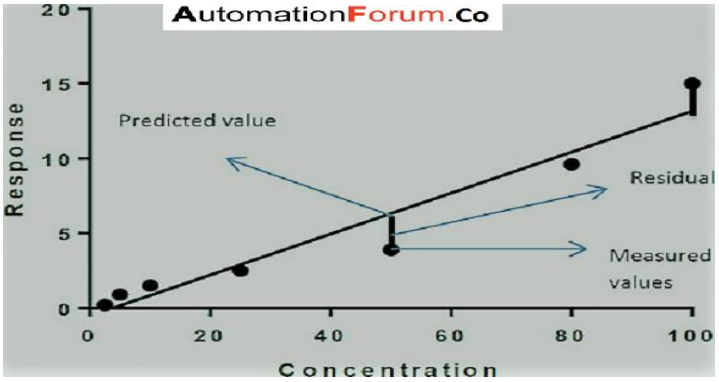

Figure 6: Linearity calibration error

This error causes the instrument's response function to no longer to be a straight line. We must consider the manufacturer's document on how and why linearity adjustment works. Because the behavior of linearity adjustment is unique for each instrument. If an instrument does not provide a linearity adjustment, the best thing to do is "split the error" between high and low extremes. Hence we can minimize the maximum absolute error.

4. Hysteresis error:

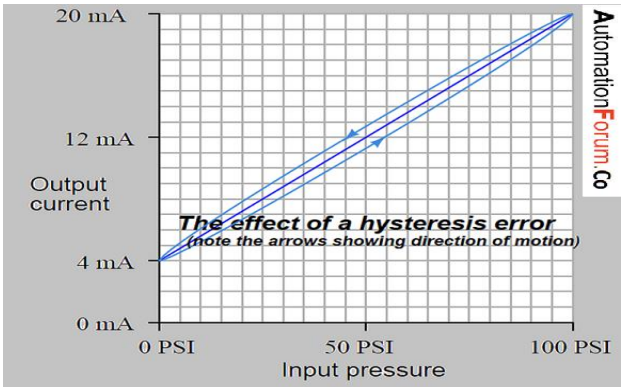

Figure 7: Hysteresis error

The instrument responds differently to an increasing input compared to a decreasing input, this is due to hysteresis error. By doing up-down calibration test hysteresis error can be detected. This type error is almost caused by mechanical friction. Friction always acts opposite to the direction of motion. That is the reason why

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the output of instrument lags when hysteresis error occurs.

IV. CONCLUSION

Studies have demonstrated that control valve calibration before calibrating the positioner of control valve, we have to familiar with all components of the instrument and required safety measures should be taken. We have to make sure that the pressure level of air supply is at required level that is at 3-15 psi for almost all cases. Control valve calibration step by step procedure to follow and the development

V. REFERENCES

[1] Control valve, fifth Edition, Emerson, Fisher.

[2] https://instrumentationtools.com/control-valve-calibration/