A Simple Method to Calculate the Standard Calibration Value of Differential Pressure Flow Transmitter

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Abstract:

Differential pressure flow transmitter is one of the combination instruments with pneumatic instrument and electrical unit and usually used with standard orifice plate. It is an important instrument widely used by the industrial enterprises for energy measurement and trading settlement. Generally, the flow transmitter is calibrated by maintenance and verification personnel on site. During calibration, the flow value will be converted into differential pressure value. To calibrate a differential pressure flow transmitter, complicated calculation is required before the standard signal input values at each point are determined. This may lead to more workloads on the maintenance and verification personnel on site and likely occurrence of errors. Besides, this makes it difficult to increase the efficiency of calibrating centralized control measurement instruments. In practice, the author finds a simple method to calculate the standard input calibration value of flow transmitter based on the design value of the instrument scale and the calculated value of maximum differential pressure. This method is applicable to the calculation of the input calibration value of the differential flow transmitters equiped with the standard orifice plate flowmeter for all other countries. It is hereby recommended.

1. Substitution of Simplified Calculating Formula for Complicated Calculation

The simple multiplication in this method can substitute the square operation usually required for conversion from flow value into differential pressure. Use the formula $a_1 \times a_2 \times \triangle p$ to calculate the standard input calibration value at each point.

Where:

a_1–Calibration point of instrument scale;

a_2–Ratio of instrument scale flow over maximum flow

$\triangle p$–Maximum differential pressure of instrument

For example 1

4 × 0.04 × 30KPa=0.16 × 30KPa=4.8Kpa, which means that the standard input signal is 4.8Kpa.

To calibrate the scale of this instrument according to common method, it is required to calculate firstly the flow at this instrument scale and then calculate and input the standard differential pressure value based on the flow at this scale vs. maximum flow and maximum differential pressure, namely:

① 15000×40%=6000

② Input standard differential pressure

$$\triangle P=\left(\frac{6000}{15000}\right)^2\times 30=4.8KPa$$

Obviously, this simple calculation method is simpler than the common method, but the result is the same.

2. Feasible standard Calibration Value Checklist

Table.1 Calculation Sheet for Standard Calibration of Differential Pressure Flow Transmitter

Scale Value of Transmitter with Head (%)	Formula to Calculate the calibration value at each point (a_1, a_2, $\triangle P$)	Standard Differential Pressure ($\triangle H$) KPa
0	0	0
10	1×0.01×30	0.3
20	2×0.02×30	1.2
25	2×0.025×30	1.5
30	3×0.03×30	1.7
40	4×0.04×30	4.8
50	5×0.05×30	7.5
60	6×0.06×30	10.8
70	7×0.07×30	14.7
75	7×0.075×30	15.75
80	8×0.08×30	19.2
90	9×0.09×30	24.3
100	10×0.10×30	30.0

Take the flow transmitter from Japan YOKOGAWA Instrument Factory as the example. The dial scale is uneven graduation mark from 0 to 10 (percentage of nominal value); the maximum range is 15000m^3/h, and the maximum differential pressure is 30KPa. Let's calibrate the 4th point on the dial of transmitter head and the result with the simple formula is obtained, as specified in example 1: The standard input for calibration at other points are listed in the flow transmitter standard input calculation sheet (Table 1).

3. Steps and Methods of On-site Calibration (Focus on the description of the pneumatic differential pressure flow transmitter)

3.1 Equipment: Two sets of portable standard manometers with a precision Class 0.25, in which: 1 set with a range 0-60KPa and 1 set with a range 0-160KPa; one piece of pressure regulating valve (0-250KPa); appropriate dimension of rubber hoses (ϕ 6mm); some T-junctions (ϕ6mm).(As shown in Fig.1)

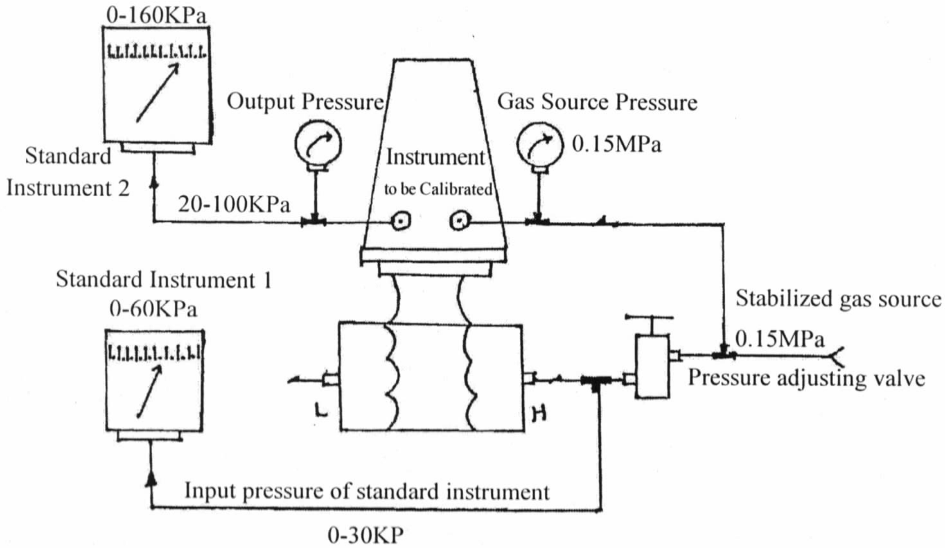

Fig.1 Piping Layout for Calibration of Differential Pressure Flow Transmitter

3.2 Airtight Test: Supply gas at a pressure 0.15MPa to the calibrated instrument. Slowly rotate the vernier pressure value with your hand and set the input gas pressure signal at 50% (i.e. middle value of the calibrated instrument). When the output pressure is stabilized at 60KPa, read out the standard indication value. Apply cleaning solvent to the calibrated pipe and joint and check if there is any leakage. No leakage is allowed.

3.3 Calibration: According to international uniform standard, the gas pressure signal is 20-100KPa. Firstly, calibrate the zero value of the instrument. After gas supply, check if the output pressure of the calibrated instrument is stabilized at 20KPa read from the scale of the standard instrument. If the reading is higher or lower, adjust the zero screw of the instrument. Rotate clockwise to increase and counterclockwise to decrease the output pressure, making it stabilized at 20KPa (i.e. zero scale). After completing the zero adjustment, slowly rotate the pressure regulating valve and input the standard gas

pressure signal to maximum value of the instrument (i.e. range value scale at 0-30KPa). After the output value is stabilized at 100KPa, read the scale value of the standard instrument. If the value is higher or lower, adjust the range screw of the instrument. Rotate clockwise to increase and counterclockwise to decrease the maximum value, making it keep unchanged. After completing the range adjustment, slowly decrease the input gas pressure signal down to zero value. At this moment, the input pressure is also decreased to and kept unchanged at 20KPa. In case of any change, again adjust the zero screw and input signal to rise to the maximum value. In case of any further change, adjust the range screw. Through two or three times of adjustment relating to inputs of the increase and decrease signals, both the zero value and range value shall be stabilized and kept unchanged till the instrument is well adjusted. For this purpose, it is proposed to establish standard input calibration value for different points, e.g. 0%, 25%, 50%, 75% and 100%. These five points are nominal value of the flow meter and can be found out in Sheet 1. The 1st point is zero value, the 2nd point is lower linear value, the 3rd point is middle value, the 4th point is upper linear value and the 5th is range value. Calibrate the advance travel and return travel. In both the advance and return travel, the zero value and range value of the instrument shall conform the accuracy requirements. Only when the reading at a point 25% or 75% exceeds the basic error of the instrument, which is called the lower linear error or upper linear error, it is permitted to adjust the linear screw. Rotate clockwise to increase and counterclockwise to decrease (Generally, it is set at factory). After the linear error is properly adjusted, the zero and range must be calibrated again, otherwise the measurement error of the instrument will be over-range. During calibration, properly fill in the calibration sheet. The output pressure value should correspond the input standard gas pressure signal; otherwise the instrument is not acceptable.

Note: ① The Calculation Sheet 1 is applicable to calibration of the differential pressure flow transmitter and smart flow transmitter with no instrument gauge scale display of the other countries.

② The arrangement for the standard calibration differential pressure flow transmitter for the electric unit is the same as that for the gas unit. The difference lies that output is the standard current signal 4-20mA and the power supply is 24V DC. The input standard value is the same in use of this calculation sheet to .

③ If the zero value and range value are not stabilized twice during adjustment, you may use range over-adjustment method (i.e. increase the input of rising range value by 0.25%) to stabilize the adjustment at the first trial.