

Vortex Flowmeter Calibration

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Abstract: Vortex flowmeter is a flowmeter based on the principle of fluid vibration. It has the advantages of small pressure loss, wide range, large measurable flow range and high precision. It is widely used in industrial production. This article mainly tells about the calibration and detection process of vortex flowmeter, using standard meter method gas flow standard device or sonic nozzle method gas flow standard device. According to the verification regulation of vortex flowmeter, it describes the working principle of the flowmeter, the requirement of measurement performance, related technical parameters, testing conditions and methods. The flowmeter is measured by the forward blow or blow back method, and the uncertainty and repeatability are obtained by analyzing the data, and the relevant verification certificates are issued.

Keywords: Vortex Flowmeter, Calibration Device, Measurement Uncertainty, Calibration Certificate

I. INTRODUCTION

A. Introduction of vortex flowmeter

Vortex flowmeter, also known as Karman vortex flowmeter, is a new flowmeter based on Karman vortex principle. The flowmeter has the characteristics of simple circuit structure, easy installation and commissioning, wide range, low pressure loss, low power consumption, high precision, output signal proportional to flow, wide measurement range, etc. it is suitable for the flow measurement of gas, low viscosity liquid and saturated steam.

B. Working principle of vortex flowmeter

Vortex flowmeter is based on Karman vortex principle and Strouhal's relationship between vortex generation and vortex flow to measure the flow of gas, liquid and steam. According to the fluid oscillation principle, when the fluid flows through the pipe, a triangular column is vertically inserted into the table body, that is, the vortex generator. When the medium flows through the table body, vortices with opposite directions and alternating arrangement are generated on both sides of the vortex generator, which is called Karman vortex. Its vortex circuit structure is simple, easy to install and debug, wide range, low pressure loss and low power consumption. It is suitable for the flow measurement of gas, low viscosity liquid and saturated steam.

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II. VERIFICATION CONDITIONS AND REQUIREMENTS

A. Verification environmental conditions

1. Calibration laboratory conditions: temperature: 23.3 °C; Relative humidity: 45%; Atmospheric pressure: 100.35pa.
2. Medium conditions for calibration: air, medium temperature: 23.3 °C, medium pressure: 100.35kPa.
3. Water is used as the medium when measuring liquid and air is used as the medium when measuring gas and steam.

B. Verification flow device

1. The flow device and its supporting instrument devices shall have a valid verification certificate.
2. The fluid temperature can be measured directly from the hole in the surface body, and if there is no temperature hole, it can be determined according to the relevant requirements.
3. The fluid pressure can be measured directly on the meter body, and if there is no pressure hole, it can be measured according to the relevant regulations.

III. INSTALLATION OF VORTEX FLOWMETER

A. Installation of instrument head

1. Use the manual key to start the equipment, power on the instrument and enter the self inspection system for analysis and inspection.
2. After the self inspection is correct, enter the parameter setting and set the working temperature, flow, pressure, medium density and upper and lower limit alarm values.
3. Enter the calibration system to start calibration, query the calibration results through the display function, and save the records.

B. Installation of instrument output wiring

1. One of the positive and negative poles of vortex sensor channel 1 and channel 2 is connected to the meter.
2. The pressure sensor is connected with the terminal corresponding to the meter.
3. The temperature sensor is connected with the corresponding wiring terminal of the instrument.

IV. CALIBRATION METHOD OF VORTEX FLOWMETER

Standard meter method and gas flow standard device are mainly used for calibration and measurement.

A. Measurement principle:

Take the standard flowmeter as the standard device, connect the standard device and the tested flowmeter in series, measure the flow of fluid flowing through the standard flowmeter and the tested flowmeter at the same time, and compare their values to determine the performance of the tested flowmeter.

B. Equipment composition:

The device consists of high-pressure centrifugal fan, silencer, heat exchanger, surge tank, gas dual turbine flowmeter (standard flowmeter is composed of 7 gas dual turbine flowmeters in parallel), wind tunnel device and pipeline to form a positive pressure loop detection system, and is equipped with computer operating system for detection and control.

C. Detection method:

Gas measurement by positive pressure method.

D. Device features:

The device reserves a wind tunnel test interface for wind tunnel test measurement and chimney flue gas flow measurement; Online calibration of the standard meter is realized, which is associated with the sonic nozzle device through the pipeline for control; The calibration can be completed without disassembling the standard table to avoid human error in the disassembly process.

E. Operation steps:

(1) Installation of large diameter pipeline

First, install the pipeline with the corresponding diameter of the tested flowmeter on the flatbed truck, and install the pipeline in sequence according to the "matching installation number table of pipeline and flatbed truck".

(2) Turn on the power cabinet

Start the distribution cabinet that controls the whole circuit of "large diameter standard meter method gas flow standard device", push the switch first, and then press the green button; Turn on the switch of PLC control cabinet in the central control room. Open the frequency conversion cabinet and press the green button marked "16A".

(3) Clamp the tested flowmeter

According to the specification and model of the flowmeter, select the bench to install the inspected table, and record the type, model and specification, accuracy grade, manufacturer and factory number of the inspected flowmeter. When clamping the meter, ensure the tightness with the connecting pipe and the correct direction of fluid flow.

(4) Wiring

Connect the power line and signal line with the tested meter as required.

F. Operating procedures:

Turn on the computer, double-click the "verification system" icon on the display desktop to enter the software operation interface of large caliber device. On the software interface, click the "meter holder" icon and fill in the information of the inspected table as required, including: the number of the inspected table, the name of the inspected table, manufacturer, model and specification, affiliated unit, pipe diameter, inspection unit, maximum flow, minimum flow, accuracy grade and instrument coefficient K. mainly note that the instrument type cannot be selected incorrectly, The power supply voltage and signal type shall be selected and filled in after being determined with the manufacturer. Select "standard condition" or "working condition" according to the requirements of the inspected table. Click "confirm" after completing the information of the inspected form.

Click the "valve" icon in front of the standard table of large-diameter software interface, open the valve, and select several pipelines according to the flow (the flow range of each pipeline is $325\text{m}^3 \sim 6500\text{m}^3$, Select several pipelines accumulatively according to the flow and open the corresponding pipeline valves).

Then click the "regulating valve" icon behind the standard table of large diameter software interface to adjust the opening to 100%. Click the "verification parameters" icon at the top of the interface to enter the verification parameter setting interface, and set the "verification points", "verification times", "flow points", "verification time" and other parameters according to the verification regulations of the tested table. The environmental conditions such as pressure, temperature and humidity shall be input according to the laboratory conditions. On the frequency conversion cabinet, press the green button marked "fan". Click the "blower" icon on the large diameter software interface. FM. Adjust the frequency by increasing the frequency value, observe the "standard quantity" icon on the left side of the interface, the flow is adjusted by increasing the frequency, and stop adjusting the flow when the standard quantity approaches the flow to be inspected. "Frequency of the meter to be checked", start the verification after the temperature and pressure are stable. Start the verification.

Click "this time" on the left of the interface to start the first verification of the first point of the meter to be checked, and click "verification record" on the upper right of the interface Icon to view the verified data. When the first verification of the first point is completed, click "next" on the left of the interface to start the second verification of the first point of the tested table. When the first verification of the tested table is completed, click "next verification", click in the pop-up dialog box. If it is necessary to re verify a flow point of the verified table, fill in the flow point to be changed in the "change verification point to point 0 for the first time" on the left of the interface, then click the "replace" icon behind, and then click "this re inspection" Start to re verify the changed flow points; wait for about 5 seconds after each verification, and then conduct the next verification after the frequency of the verified meter is stable.

Click the "verification record" icon at the top right of the interface, fill in the certificate number at the top right of the original record form, and then click "save" in the interface Icon, the record will be saved automatically. After verification, click the "regulating valve" icon behind the standard meter to zero the regulating valve; click the "valve" icon in front of the standard meter; click the "meter holder" icon → click "yes"; click the "exit system" icon. Power off, press the green button on the distribution cabinet to close the switch; close the frequency conversion cabinet, press the button marked below Press the red button of "fan" marked with "16A" to turn off the power and end the verification.

V. PROCESSING OF CALIBRATION RESULTS

A. Data analysis

The following conclusions can be obtained through the calculation of indication error:

1. Appearance: meet the requirements; tightness: meet the requirements.
2. The indication error of the instrument is 0.99%, and the repeatability is 0.216%.
3. The table is qualified after testing.

B. Calibration certificate

Fill in the name of calibration unit, calibration date, instrument number information, specification and model, test environmental conditions (temperature and humidity values); input calibration result data, calculate repeatability and uncertainty; print certificate, bind and label.

VI. PROBLEMS ENCOUNTERED DURING CALIBRATION AND SOLUTIONS**A. Fault phenomenon: the measurement result has large error.**

Possible causes: preheating is not conducted before testing; the back pressure ratio is too large during standard meter method testing, and the measurement is started when it is not stable at about 0.5; the measurement times are less; the power supply voltage of the flowmeter is too large; the pipeline leaks during testing; and the setting of measuring range and flow range is inaccurate.

Troubleshooting: preheat for 5 minutes before testing; adjust the current to stabilize the back pressure ratio at about 0.5; increase the measurement times; reduce the power supply voltage; enhance the tightness; check the measuring range and flow range of the instrument and set it correctly.

B. Fault phenomenon: the pipeline leaks during measurement.

Possible causes: the connection between the tested flowmeter and the pipeline is not tightly sealed; the pipeline is corroded or the pressure is too high; the equipment is not inspected regularly beyond the service life.

Troubleshooting: install the sealing gasket on the clamping flow meter to prevent loose sealing; take anti-corrosion measures and adjust the pressure in the pipeline; maintain and replace the equipment regularly.

C. Fault phenomenon: the calculation repeatability error is large.

Possible causes: the pipeline pressure is unstable and fluctuates greatly; the current is adjusted too fast and there is no buffer time; there is human eye error in reading; the measurement times are less.

Troubleshooting: adjust the installation position of the flowmeter to ensure the tightness; slowly increase the current input value according to the current change mode; keep the level with the measuring instrument when reading; increase the measurement times.

D. Fault phenomenon: there are impurities in the pipeline, causing danger.

Possible cause: impurities are introduced into the clamped flow meter. When the standard device works, strong air flow is generated, which makes the impurities run at high speed and affect the Troubleshooting: carefully check whether impurities are substituted when installing the inspected table; check whether there are impurities in the pipeline before running the system.

E. Fault phenomenon: the sensor makes an abnormal roar.

Possible causes: the gas flow in the measuring pipeline is large; the pipeline is loose due to excessive flow rate; there is leakage due to incomplete sealing during installation.

Troubleshooting: run for a period of time and measure after the air flow is stable; adjust the current to reduce the flow

speed; check whether there is leakage in the installation pipeline.

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