1. Functional use and scope of application of the product

Insertion of electromagnetic flow sensor (referred to as sensor) and electromagnetic flow converter (referred to as converter) supporting the insertion of electromagnetic flowmeter (referred to as flowmeter) is used to measure the volume flow rate of a variety of electrically conductive liquids in the pipeline.

The sensor has the following characteristics:

◆ No moving parts in the sensor, simple structure, reliable work.

◆ Plug-in structure allows easy installation and removal without stopping water under low pressure or pressurized conditions. Therefore, it is very suitable for fluid measurement in existing pipelines and easy maintenance and repair of the instrument.

◆ Measurement accuracy is not affected by changes in physical parameters such as temperature, pressure, density, viscosity, conductivity (as long as the conductivity is greater than 5μs/cm) of the measured medium.

◆ The sensor has virtually no pressure loss and very low energy loss.

◆ Lower manufacturing cost and installation cost than general electromagnetic flow meter. Especially suitable for large and medium diameter pipeline flow measurement.

◆ Adopts advanced low-frequency square wave excitation. Stable zero point, strong anti-interference ability, reliable operation.

◆ Large flow measurement range. The full-scale flow rate in the measured pipe can be set arbitrarily from 1m/s to 10m/s, and the output signal has a linear relationship with the flow rate.

◆ Flow meter not only has 0~10mA◆DC or 4~20mA◆DC standard current output, but also 1~5kHz frequency output.

Because the flow meter (sensor) has the above series of advantages, therefore, has been widely used in chemical industry, chemical fiber, metallurgy, fertilizer, paper, water supply and drainage, sewage treatment and other industrial sectors and agricultural irrigation water metering conductive liquid flow measurement and automatic control of production processes....

2. Product type and composition

The type of the product is insertion type. It is connected to the pipeline through the mounting base, ball valve and compression nut and positioning screw. Sensor measurement is divided into two structural types: measuring tube type and flat electrode type. Measuring tube type sensor is suitable for measuring clean media; plane electrode type is suitable for measuring the liquid flow measurement in the medium containing other impurities.

3. Main technical performance

1 Suitable for measuring pipe diameters:

200~2000mm;

2 Flow rate measurement range:

0~1 to 0~10m/s, full scale is continuously adjustable within 1~10m/s range.

3 Measurement accuracy

±1 5% when full scale flow rate >1m/s.

4 Conductivity of the measured medium:

greater than 50 μs/cm.

5 Work stress:

1.6Mpa.

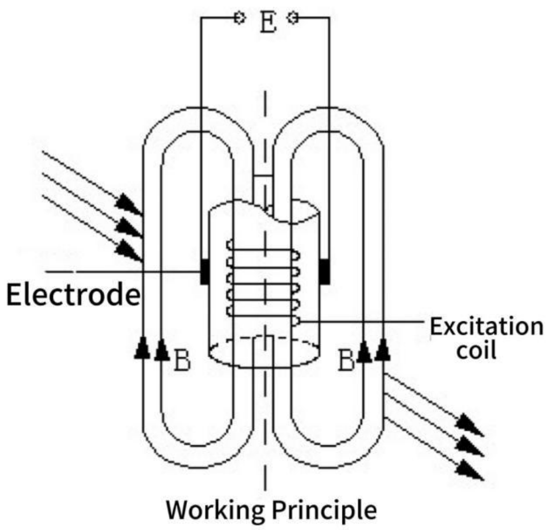
6 Electrode materials:
Molybdenum-containing stainless steel 0Cr118Ni12Mo2Ti, Hastelloy c-276, Titanium Ti, etc.
7 Measuring tube (measuring head) material:
ABS
8 Maximum temperature of the measured medium:
ABS60℃
9 Enclosure protection rating:
Comply with the relevant provisions of GB-08-84 standard IP68.
10 Sensor output signal:
0.209mVp-p/1m/s.
4.11 Maximum signal transmission distance between the sensor and the converter is 50m (please contact the factory for special requirements)
4.12 Flow meter output signal:
DC current: 0~10mA load resistance is 0~1kΩ;
4~20mA load resistance is 0~500Ω;
Frequency: 1~5KHz Load resistance is 250~1.2kΩ.

4. Principles of operation and structure

4.1 Principle of operation
The sensor is actually a liquid flow rate measurement instrument. It is the application of Faraday's law of electromagnetic induction principle made of flow rate measurement instrument. Figure 1 is a schematic diagram of the basic working principle of the insertion type electromagnetic flow meter.
With a long rod will be a small electromagnetic flow sensor inserted into the pipeline to be measured in the specified position, the conductive fluid flowing perpendicular to the sensor's operating magnetic field (converter to provide excitation current to the sensor, in the excitation coil of the excitation system to produce the operating magnetic field), the equivalent of the conductor in the field of cutting the line of magnetic force movement. According to Faraday's Law of Electromagnetic Induction, an induced electromotive force is generated at both ends of the conductor. This induced electromotive force is detected by a pair of electrodes in contact with the fluid. The magnitude of the electromotive force is proportional to the magnetic induction strength B, the distance L between the poles and the average flow rate of the fluid. i.e.

E=B-L-V (volts) ①

Where: E - induced electromotive force, volts;
B - magnetic field strength, tesla;
L - distance between the two electrodes, meters;
V - flow velocity through the electromagnetic flow sensor (i.e., representing the mass flow velocity at the specified insertion point of the pipe under test), m/s
K - coefficient.



The factory inserted electromagnetic flow rate sensor specified insertion point there are two ways, one is inserted into the center axis of the pipeline to be measured; the second is inserted into the inner wall of the pipeline is about the pipeline 0.121D, D is the diameter of the pipeline, generally less than DN400 pipeline can be inserted into the center axis of the pipeline to be measured, at this time the electromagnetic flow rate sensor to measure the flow rate sensor measurement flow rate of the pipeline's maximum flow rate, the pipeline's average flow rate should be by the Maximum flow rate multiplied by a factor *K*.

$$K = \frac{2n^2}{(n+1)(2n+1)} \text{(For smooth pipes)} \qquad ②$$

Where: n is the Reynolds number index, can have ③ formula to obtain.

n=1.66lgRD

Where: RD - Reynolds number of the pipeline fluid.

$$K = \frac{1}{1 - \frac{0.72}{\lg(0.2703 \times \frac{K}{D} - \frac{5.74}{R_D^{a \cdot 9}})}} \text{(For rough pipes)} \qquad ③$$

Where, K - equivalent absolute roughness, the average height of protrusions in the inner wall of the pipe.

Pipes larger than DN400 can be inserted to about 0.121D from the inner wall of the pipe. At this time, the electromagnetic flow rate sensor measured flow rate for the average flow rate, coefficient K = 1. The measured flow rate of the pipe can be expressed by the following formula

Q = B - V - A (m3/h) ④

Where, A - circular pipe cross-sectional area, m ². By substituting ① equation into ② equation, we get

$$Q = \frac{E}{BL} A \qquad ⑤$$

Since the insertion of electromagnetic flow rate sensor working magnetic field strength and the distance between the two electrodes has been determined at the time of manufacture, at the same time, the cross-sectional area of the pipeline to be measured is also derived, so the size of the output electromotive force of the insertion of electromagnetic flow rate sensor can be representative of the size of the flow rate.

4.2 Structure

The sensor, as shown in Figure 2, is mainly composed of a measuring head (or measuring tube), an excitation system, an insertion rod, a junction box, a mounting base, and a sealing and positioning mechanism.

Measuring Head (or Measuring Tube): The measuring head (or measuring tube) is located at the point of mass of the flow velocity of the measured stream in the pipeline and is used to detect the flow velocity at that point. Measuring head (or measuring tube) made of insulating material end or conduit, in which a pair of electrodes are installed. Except for the electrode tip or the inner wall of the measuring tube, the other parts are insulated from the measured fluid.

Excitation system: The function of the excitation system is to generate an operating magnetic field. It consists of an excitation coil and an iron core. It is insulated and sealed into the insertion rod.

Insertion rod: made of stainless steel. The measuring head east measuring tube is fixed inside the insertion rod. The excitation and electrode leads are sealed from the measured medium through the insertion rod and connected to the junction box. The insertion rod is welded with a directional indicator bar, which is used to ensure that the working magnetic field, the flow velocity and the electrode lines are perpendicular to each other during installation, in accordance with Faraday's Law of Electromagnetic Induction.

Junction box: The junction box is located on the upper part of the sensor. The terminals in the terminal box are used to connect the sensor to the transducer.
Mounting base: The mounting base is the part welded to the pipe to be measured and used to connect with the mounting ball valve and insert the electromagnetic flowmeter sensor.
Sealing mechanism: made of stainless steel material compression threaded seat, compression nut, rubber washers and positioning screws and other components. Used to seal the insertion of electromagnetic sensors, so that it can withstand a certain working pressure.

5. Installation and use

5.1 Installation

5.1.1 Selection of installation environment

①Should try to stay away from equipment with strong electromagnetic fields, such as large motors and transformers.

②There should be no strong vibration in the installation place, and the pipes should be fixed firmly. The ambient temperature should not change much.

③ The installation environment should be easy to install and maintain.

5.1.2 Selection of mounting position

① The installation position must be such that the pipe is always filled with the measured fluid.

② Select the place where the fluid flow pulse is small. That is, it should be far away from the pump and valves, elbows and other local resistance pieces.

③ When measuring two-phase (solid and liquid or gas and liquid) fluids, choose a place that does not easily cause phase separation.

④ Negative pressure at the measurement site should be avoided.

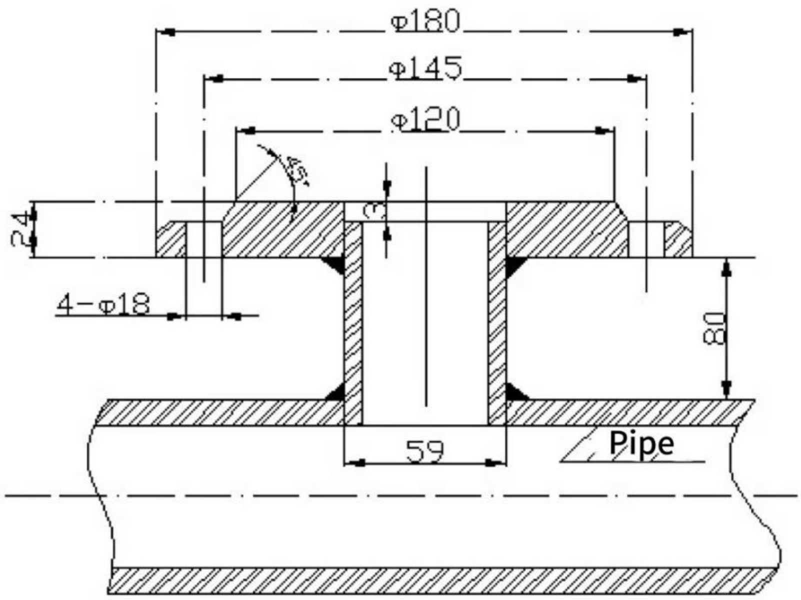
⑤ The diameter or circumference of the pipe being flanked is easy to measure and should be less elliptical.

5.1.3 Length of straight pipe sections

The length of the straight section of the upstream side of the sensor installation pipe should be greater than or equal to 10D, and the downstream side should be not less than 5D. D is the diameter of the pipe to be measured.

5.1.4 Flow control valves and regulating valves

The flow control valve should be installed on the measured pipe on the upstream side of the sensor, and the flow regulating valve should be installed on the downstream side of the sensor. Normally the flow control valve should be fully open during measurement.



Welding of mounting base

5.1.5 Welding of mounting bases

The mounting base is welded to the pipe under test as shown in Figure 3.

The technical requirements for welding are as follows:

① The axis of the mounting base 63 pipe is perpendicular to each other and the axis of the pipe under test.

Its angle is

②Use stainless steel welding rod flat welding. After welding to ensure that the end face of the flange and pipe axis parallel to the weld seam firmly, can withstand 1.6Mpa pressure without leakage.

③ The size of the measured pipe opening is the same as the outside diameter of the through-hole of the mounting base.

6.2 Inspection before installation

6.2.1 Inspection of sensors before installation

a. Before installation, use an alcohol cotton ball or clean fine gauze to gently and carefully wipe off grease, dust and other stolen substances on the surface of the two poles of the sensor measurement head. However, do not damage the electrode surfaces and insulating materials with something hard.

b. Check the sensor with a multimeter before installation to meet the following specifications:

①Excitation coil resistance check: use a multimeter to measure the resistance between "X, Y" terminals in the junction box is about 40 or so. If the measured resistance value is infinity, then the coil is broken; if the resistance value is zero, then the coil is short-circuited.

② Electrode to terminal resistance: terminal "A, B" in the junction box, respectively, on the measuring head or measuring tube of the two electrodes a zero . If one for infinity or all for infinity, are faulty.

③ Insulation resistance check: resistance between excitation coil, signal terminal and insertion bar is infinity. Terminal C to insert the rod resistance is zero . Use a multimeter to measure the resistance between terminals "A, B" and "C" and "X, Y" and "C". The resistance between terminals "A, B" to "C" and "X, Y" to "C" is infinite, and the resistance between terminals "C" to the insertion rod is zero. . The resistance between terminals "A, B" and terminals "X" and "Y" is infinity.

If there is any inconsistency between the measurement and the above, please contact the factory.

5.3 Measurement of the internal diameter of the pipe under test

5.3.1 When it is possible to measure the internal diameter of the pipe, a vernier caliper or steel tape measure may be applied to at least four diameters in the pipe at approximately equal angles to each other for side measurement. If the difference between two adjacent diameters is greater than 0.5%, then buy the number of measurements doubled, take the arithmetic mean of the diameter as the pipe diameter.

5.3.2 When it is not possible to measure the internal diameter of the pipe directly, the internal diameter can be calculated by measuring the circumference and wall thickness of the pipe.

$$D = \frac{L - l}{\pi} - 2e \qquad ⑥$$

Where: D - internal diameter of the measured pipe, meters; L - outer circumference of the pipe, meters; l - circumference correction, meters; e - wall thickness of the pipe, meters.

Using this method, the outer surface of the pipe should be carefully roughened, and if there are any high spots, such as welds, the corrected value for each high spot, calculated by the following formula, should be subtracted from the measured circumference: $L = \frac{8}{3} a (\frac{a}{D})^{1/2}$ ⑦

Where: a - height of the high point; D - inner diameter of the pipe.

5.4 Installation of sensors

5.4.1 Clean weld slag and burrs from the installed base of the pipe under test.

5.4.2 Turn off upstream flow control valves or use low pressure water supply.

5.4.3 Install the DN50 ball valve onto the mounting base as shown in Figure 3. Note that the long cavity of the ball valve is upwards. Check that the ball valve can be fully opened and closed. Repair if there is any problem. Install the compression threaded seat, compression nut and rubber seal onto the ball valve. Loosen the set screw and compression nut and insert the sensor insertion rod through the ball valve into the pipe under test. Insertion depth is calculated by 6.4.4 and measured by vernier calipers or steel tape measure, after meeting the requirements, tighten the compression nut and positioning screw, and should pay attention to the direction of the sensor marking rod pointing to be consistent with the direction of fluid flow.

5.4.4 Measure the distance between the sensor electrode and the direction marking pole with vernier calipers or steel tape measure. Set the measured length between the sensor electrode and its direction marking pole as H. For D≤400mm, the insertion depth can be calculated by the following formula The insertion depth can be calculated by the following formula The insertion depth E is:

$$E=H-0.5D$$

For D > 400 mm through diameters

$$E=H-0.121D$$

When you need to find out the insertion depth more accurately, you can use the following formula to calculate the direction of the pipe diameter, the distance from the inner wall to the measuring point Y

$$Y = \left(\frac{2n^2}{(n+1)(2n+1)}\right)^2 \times R$$

Where, R - the inner radius of the pipe. Insertion depth

E=H-Y

5.5 Cable laying and wiring

The laying of cables is divided into two kinds of open number and dark number. The use of which number of settings depends on the site-specific conditions.

Figure 4 shows the electrical wiring diagram between the sensor and the converter. As can be seen from the figure, there are two cables between the sensor and the converter. One is the excitation line that the converter provides excitation current to the sensor, and one is the signal line that the sensor outputs electromotive force to the converter.

The following points must be observed when laying and wiring cables:

Signal cables should not be laid in close proximity and parallel to external high current power cables. Signal cables should be electrically shielded from outside cables through steel pipes. The steel pipe should be connected with the earth line.

② When laid openly, the signal cable should be more than 1 meter away from the power cable. Signal cable and excitation cable should also maintain a certain distance. Laying through the steel pipe, the excitation cable should also be separately through the pipe.

③The distance between the sensor and the converter is generally 50 meters, special circumstances require the extension of the cable, you should contact the factory. The factory with the signal cable and excitation cable model RWP type double-core polyethylene insulation shielding cable, specifications for the 2 × 32/0.2 OD ф8mm, length of 15 meters. If you have special requirements, please specify to the factory when ordering.

④The factory is not responsible for the converter power supply cable and output current and frequency cable. Since these two cables require only a few dozens to a few hundred milliamps of load current, and the transmission distance is related to the distance from the site to the control room, users can prepare their own power supply and output signal cables according to the actual needs.

⑤ Connect the wires according to the converter and sensor terminal markers shown in Figure 4, one by one.

5.6 Grounding

The flow signal generated by the sensor is very weak, usually on the order of microvolts or millivolts. Therefore, preventing the influence of external electrical interference is an important factor in using a good flow meter. Grounding is a very effective measure to address the effects of electrical interference.

Sensor grounding requirements are primarily the grounding of the measured medium. Sensor and converter grounding (terminal "C" and flow signal cable connected to the metal shielding network, and through the inserter rod and the measured medium connection. When the measured pipe is a non-metallic pipe, in order to ensure good grounding, the sensor grounding terminal directly with the earth plus a grounding wire. Requirements for grounding resistance should be less than 10Ω

5.7 Preparation for use

① After installation and wiring, the installation and wiring should be checked again for correctness before formal use.

② Open the flow control valve upstream of the sensor, then open the downstream flow control valve and allow the fluid to drain for a few minutes, then allow the gas contained in the fluid to drain with it. Close the downstream flow control valve and the upstream flow control valve and allow the piping to fill with fluid, but not flow.

③ Check the following technical specifications of the sensor with a multimeter:

A The resistance between the excitation terminals "X" and "Y" and the grounding terminal "C" is infinite.

B Ground terminal "C" and insert the rod between the resistance is zero.

C Multimeter set at x1KΩ file, with a black test pen to point to the terminal "C", the red pen were pointed to the terminal "A", "B", the resistance value of 10 ~ 30KΩ, and there is a charging and discharging Phenomenon.

④Check that the supplied power supply voltage and frequency should be in accordance with the provisions of the converter installation and use instructions, and turn on the converter power.

⑤With a multimeter DC voltage 2.5V or 10V file to measure the sensor terminal "X" and "Y" voltage between the multimeter pointer has a number of times a second of low-frequency oscillation phenomenon. Explain that the sensor excitation system is working properly.

5.8 Adjustment and use

① If the size of the measured pipe flow is known, the flow range can be set according to the size of the measured pipe flow and the range setting method of the converter installation and use instructions.

② After the completion of the preparatory work, first open the sensor upstream flow control valve, and then slowly open the downstream flow control valve, observe the converter display flow should be from small to large changes. If the display is negative, the power should be cut off the signal line "SIG1" and "SIG2" swap.

③Set the flow range value and regrettor coefficient according to the measured flow rate again as necessary by referring to the amortization described in the converter installation and operation manual.

④If the sensor is installed in the open air or buried in the ground, after connecting the terminal wire of the Horizontal device, it can be sealed with the sealing skimmer attached by the factory.

⑤ Open the flow control valve upstream of the transducer, and after opening the downstream flow adjustment valve and allowing the fluid to discharge for a few minutes, let the gas contained in the fluid discharge with it. Close the downstream flow adjustment valve and the upstream flow control valve, let the piping be filled with fluid but not flow, and zero the meter as described in the converter installation and operating instructions.

⑥ Open the upstream flow control valve, and then slowly open the downstream flow adjustment valve to meet the requirements can be put into operation. Flow rate calculation formula

$$Q = 2827.43D^2V(m^3/h)$$

Where: D - pipe inner diameter, m;

V - average flow rate of the pipe, m/s.

6. Maintenance, repair and common troubleshooting

6.1 Maintenance

Sensors generally do not require regular maintenance. However, in cases where the measured medium tends to adsorb scale on the surface or inside of the electrode and measuring head (measuring tube), periodic cleaning is necessary. The cleaning cycle depends on the rate of adhesion and fouling. When cleaning the electrodes and measuring head (measuring tube), care must be taken not to damage the insulating material and electrodes.

6.2 Repairs

If the sensor is faulty, the measurement system of the sensor excitation system can be determined to be normal according to the inspection methods described in articles 6.7 and 6.2.1 of these instructions. If there is a malfunction, contact the factory; the user must not normally carry out repairs himself.

Care should be taken to close the ball valve when the sensor is removed.

6.3 Common troubleshooting is shown in the table.

Fault phenomenon	Causes	Methods of elimination
Negative converter flow	1. Sensor direction indicator bar opposite to the fluid flow direction 2. Reverse connection between X and Y or A and B in the sensor junction box.	1. Rotate sensor direction 180° 2. Converter rewiring
Converter output over range	1. Flow meter range value is less than the actual measured value 2. Fluid not filling the pipe 3. Excitation coil open circuit	1. Expanded flowmeter ranges 2. Close the low-flow regulating valve 3. rewire
Output signal fluctuates too much	1. The presence of gas at the sensor electrode, resulting in poor contact between the electrode and the medium 2. Deposits on electrodes	1. Remove gas from piping 2. Cleaning electrodes
Output signal gradually drifts to zero	1. Sensor water ingress 2. Electrodes are covered	1. Replacement of sensors 2. Cleaning electrodes