BALANCED FLOW SENSOR

- Energy-saving
- Correct measurement
- Safety and reliability
- Extensive application

Australian Electric Control Engineering Pty Ltd

Overview

Throttling device, which is capable of resisting terrible work condition and follows international standard, becomes the preferred device for Engineering in the hundred years, wherein the throttling device has covered 70 percent of the flow rate market. Throttling device international standard ISO5167 published and implemented in 2003 required that the straight pipe of the throttling device should achieve 30 to 40 D to ensure 0.5 to 1 percent of precision. On the condition that the industrial modernization in-situ pipe diasensor is continually increased, the industrial land is increasingly tensed, the length of the straight pipe section required by flow sensor cannot be ensured, the resource is increasingly decreased, but instead of which is the sensoring of the flow sensor must be precise, the throttling device comply with incompatible standard is hard to produce and provide.

Flow sensor not only having the property of terrible work condition resistance of throttling device but also having not less than 1 percent of precision under the condition that the straight pipe to be mounted on site is short (about 5D) is urgently needed in market.

The balanced flow sensor researched, tested and provided by our company can achieve all of the requirements the above.

The balanced flow sensor is a novel throttling type flow sensor measuring instrument produced according to differential pressure type working principle; a flow rate measuring system comprises a multi-pore rectifying type throttling device, a differential pressure transmitter and a flow sensor integrating sensor and the like; the balanced flow sensor also can be networked with the control system or a computer to measure and control the flow sensor of the fluid.

The multi-pore rectifying type throttling device integrates the properties of standard pore plate with flowing conditioner to form to be an energy conservation environment-friendly flow sensor sensor. The balanced flow sensor sensor is provided with multiple function holes which can extremely balance and rectify the vortex into the fluid similar to ideal fluid; the balanced flow sensor sensor is specifically applied to the flow sensor measuring condition with short straight pipe section, high precision requirement, and complex work condition. And the balanced flow sensor has been widely applied to the industries such as chemical industry, petroleum, metallurgy, power, natural gas, water process, etc.

Primary Technology Index

- Pipeline size: 15 ⩽DN⩽ 1200 mm;
- Nominal pressure: PN⩽42MPa;
- Working temperature: -80℃⩽t⩽550℃, Special 850℃;
- Measurement range: 10:1; 15:1;
- Precision grade: ±0.5%, ±1%;
- Repeatability: ±0.1%;
- Requirement of straight pipe section: 0.5D~2D;
- Permanent pressure loss: 1/3 the pressure lose of pore plate under the same Condition;
- Structural form: flange type, opposite clamp type, welding type, integrate type;
- Measurement medium: application on measurement of gas, fluid, gas-fluid phase, fluid gas, bidirectional flow, smudge medium and size.

Principle of Work

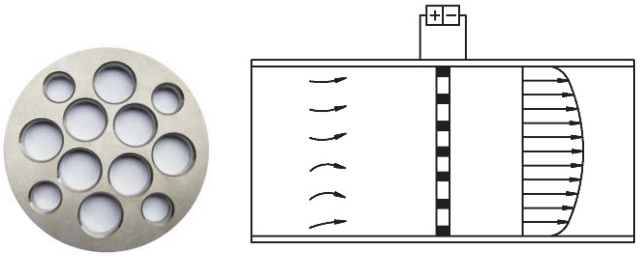
As solving the contradiction between the precision of throttling device and overlong mounted straight pipe, international standardization organization ISOTC30 have recommended flow conditioner in decades, but the flow conditioner with length about 2D cannot achieve the requirement on the length of 4 to 5D while individually mounting between the resisting component and the throttling component, and the total length is about 10D in mounting. Furthermore, the problems of increased cost and maintaining rate, and raised pressure that go with it are appeared. Our company combines two into one, and provides a throttling component similar to the flow conditioner which results in desirable effect; and the principle of work can be shown as follows: the fluid passing through the resisting component (such as elbow, valve, adapter bonnet, divided manifold) flows with irregular flow speed distribution and vortex in the pipe in complex way; in that case, the flow sensor is hard to measure. The standard

throttling device performs measurement to obtain greater precision while the fluid is flowing until fully executing turbulence flow in a straight pipe section having length of 30 to 40D under the effect of adhesiveness of self.
The balanced flow sensor provided by our company is worked as that the vortex is removed or reduced while complex flowing is passing through the function hole of the balance throttling component, as well as the fluid is conditioned into multiple flow beams flowing in the same direction; on the condition of closer distance and the same flowing direction, the flow speed distribution can be effectively balanced by the effect of the adhesiveness, and ideal flowing state is achieved in short distance. Differential pressure is generated at the front and the back of the multi-pore rectifying device, thus stable differential pressure signal can be obtained by a pressure gaining device; and the volume flow rate and the mass flow rate can be calculated according to Bernoulli equation.

Flow formula

$$Q=\frac{C}{\sqrt{1-\beta^4}}\varepsilon\frac{\pi}{4}d^2\sqrt{2\triangle P/\rho}$$

$$M=\frac{C}{\sqrt{1-\beta^4}}\varepsilon\frac{\pi}{4}d^2\sqrt{2\triangle P\cdot\rho}$$



Balanced flow sensor improved flow field figure

M-mass flow rate (kg/s) ;
C-flow rate coefficient ;
β -diasensor ratio, β =d/D;
$\triangle$P-differential pressure, Pa;
ε - expansibility factor;
ρ -fluid density, kg/m^3;
Q-volumetric flow rate(m^3/s);
d-the diasensor of throttling component with unit as, m;
D-the inside diasensor of the upstream pipeline with unit as, m.

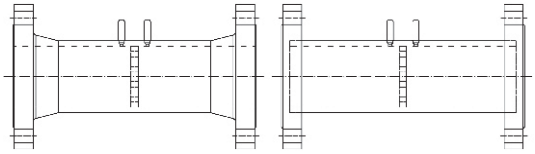
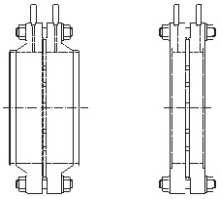
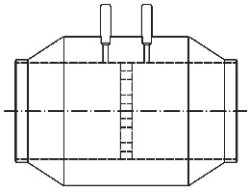
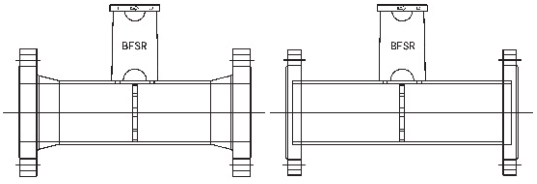
Main Characteristic

- **Special structure form**
  The throttling component and the flowing rectifying device are organically combined to form the balance throttling component which is capable of balancing and rectifying the complex flow field and removing vortex and improving flow field in short distance; furthermore, the medium noise can be greatly reduced, thus the measurement signal is more stable resulting in greater measurement precision.
- **Requirement of short straight pipe section**
  By adopting special structure of the balance throttling component, the pressure is restored 2 times quicker than that of traditional throttling device, which greatly reduces the requirement on straight pipe section; in common condition, the straight pipe section is designed as 0.5D~2D.
- **Low permanent pressure loss**
  The balance throttling component reduces (or removes) vortex by rectifying and balancing the irregular flow of resisting component, as well as accelerates to achieve the process with ideal flow and reduces the length of the necessary straight pipe section; said conditions are benefit for reducing the permanent pressure loss; the permanent pressure loss is about 1/3 of that of the pore plate throttling device based on the same
- **Improved smudge resistance**
  The balance throttling component has multi-pore symmetric structure, which greatly reduces the formation of dead area, ensures the smudge medium successfully passing through multiple pores, and reduces the problem that the fluid pore is plugged.
- **Wide measurement range application**
  The full package of the medium such as gas (air, gas, natural gas and the like), steam and liquid (chemical liquid such as water solution) and the flow rate of the bidirectional fluid can be measured; the balance throttling component is suitable for different circular pipes and quadrate pipes. The balance throttling component has unique design, and is made of high strength corrosion resisting material, thus it has high strength; and the balance throttling component is applied to the conditions such as high temperature and high pressure condition, corrosion resistance condition, and anti-explosion dangerous condition.
- **High precision and large measurement range**
  The precision is top to +-0.5%, +-1.0%; the repeatability is +-0.1%; and the measurement range is more than 10:1.

Selection Table

Project	Model Code	Code Description
Basic model	BFSR	Balanced flow sensor
Structural form	–F	flange type
	–O	Opposite clamping type
	–W	Welding type
	– I	Integral type
Inside nominal diameter	XXX	Such as 100 mean DN100
Flange standard	A	ANSI
	D	DIN
	G	CHN GB/T
	O	Other Standards
Nominal pressure	–1	0.25MPa
	–2	0.6MPa
	–3	1.0MPa
	–4	1.6MPa
	–5	2.5MPa Class150
	–6	4.0MPa
	–7	5.0MPa Class300
	–8	6.3MPa Class400
	–9	10.0MPa Class600
	–10	15.0MPa Class900
	–11	20.0MPa
	–12	25.0MPa Class1500
	–13	32.0MPa
	–14	42.0MPa Class2500
Differential pressure flow rate transmitter	N	Not match DP/flow rate transmitter
	D	Match differntal transmitter
	Q	Match Flow rate transmitter
Pressure compensation	N	Not match Pressure transmitter
	Y	Match Pressure transmitter
Temperature compensation	N	Not match Temperature measurement element
	K	Match Temperature measurement element
	P	Match Pt100 thermal resistor
Installation accessories	F	Match mounting flange
	C	Match condenser
	I	Match isolator
	A	Match a valve
	T	Match the three valve group
Pipeline material	–CS	Carbon steel (specify model of material)
	–SS	Stainless steel (specify model of material)
	–CM	Alloy steel (specify model of material)

Technical Parasensors and Application

Mount type	Flange type	Opposite clamping type
Schematic plot		
Full-diasensor range	15~1200mm	15~1200mm
Pressure stage	opposite welding flange: 0~10MPa downward welding flange: 0~2.5MPa	opposite welding flange: 0~6.3MPa downward welding flange: 0~2.5MPa
Temperature range	-80~550℃	-80~550℃
Precision stage	±0.5%、±1.0%	±0.5%、±1.0%
Measurement range	More than 10：1	More than 10：1
Application range	High temperature Middle pressure steam, gas and liquid	High temperature Middle pressure steam, gas and liquid
Mount type	**Welding type**	**Opposite clamping type**
Schematic plot		
Full-diasensor range	15~1200mm	15~1200mm
Pressure stage	0~42MPa	opposite welding flange: 0~10MPa downward welding flange: 0~2.5MPa
Temperature range	-80~550℃, Special 850℃	-80~400℃
Precision stage	±0.5%、±1.0%	±0.5%、±1.0%
Measurement range	More than 10：1	More than 10：1
Application range	High temperature high pressure steam, gas and liquid	Middle temperature Middle pressure steam, gas and liquid

Installation Instructions

Unpacking acceptance

Open the balanced flow sensor packaging box, check whether the model and quantity of the balanced flow sensor are coordinated with those of box packaging table; check whether specification, calculation sheet, information and accessory are complete; check whether the package is complete, whether the instrument is damaged; and check whether the pressure grade of the mounting flange is coordinated with that of the pipeline.

Requirement on installation of pipeline

Try to select the longest level or vertical section of the straight pipe on the in-situ technique pipeline; the minimum straight pipe is required not less than five times of the diasensor of the pipe; the pipeline should be firmly fixed without vibration; and the inside diasensor and the circle of the pipeline must keep in step of those of the balanced flow sensor.

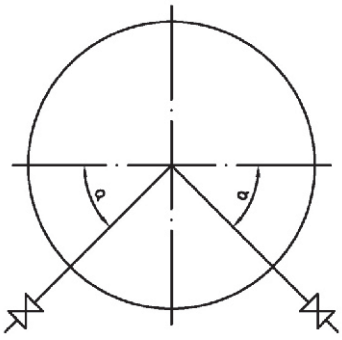
Requirement on measurement conditions of different mediums

On the measurement condition with liquid used as the medium to be measured, the balanced flow sensor should be ranged in 45 degrees below the level line of the pressure port, preferable 45 degrees, thus the bubble upwards overflowed from the liquid in the pipeline can be conveniently measured. (see the schematic plot 1)

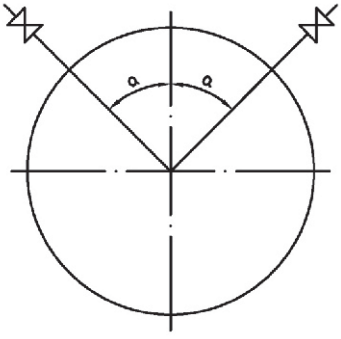
On the measurement condition with gas used as the medium to be measured, the balanced flow sensor should be ranged in 45 degrees below the vertical line of the pressure port, preferable vertical line, thus the condensing liquid reflowed from the gas in the pipeline into the pipeline can be conveniently measured. (see the schematic plot 2)

On the measurement condition with steam used as the medium to be measured, the balanced flow sensor should be ranged in 45 degrees above the vertical line of the pressure port, preferable level line, thus the condenser can be mounted in the same height as the level liquid face in the condenser. (see the schematic plot 3)

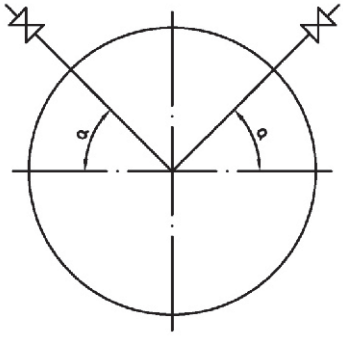
On the vertical pipeline measurement condition, the balanced flow sensor can be mounted in any direction; the pressure leading pipes at the pressure port should structure in the same height; and the levels of the condenser are equal to each other as steam measurement required.



Measure medium is liquid
a = 45 degrees
preferable 45 degree
installation schematic plot 1



Measure medium is gas
a=45 degrees
preferable 0 degree
installation schematic plot 2



Measure medium is steam
a=45 degrees
preferable 0 degree
installation schematic plot 3

Installation schematic plot of measurement system of balanced flow sensor

Installation requirement on differential pressure transmitter

The pressure leading pipe at the positive pressure side of the balanced flow sensor connects the three-valve set to the positive pressure chamber of the differential pressure transmitter; the pressure leading pipe at the negative pressure side of the balanced flow sensor connects the three-valve set to the negative pressure chamber with differential pressure transmitted;

The in-situ installation position of the differential pressure transmitter is relevant to the target medium; as the greater installation result is to be obtained, following conditions must be considered:

- The differential pressure transmitter should be prevented from being directly contacted with the corrosion or overheat medium to be measured;
- The residue should be prevented from being deposited and plugged in the pressure leading pipe;
- The lengths, the heights and the directions of the pressure leading pipes at the positive pressure side and the negative pressure side must be kept in steps;
- The liquid column pressure heads in the pressure leading pipes at the positive pressure side and the negative pressure side should keep balanced;
- The pressure leading pipes should be mounted at the position with the minimum temperature gradient and the minimum temperature variation.

While measuring the flow rate of liquid, the differential pressure transmitter should be mounted at the position lower than the target pipeline, thus the bubble in the pressure leading pipe can be guided into the pipeline;

While measuring the flow rate of gas, the differential pressure transmitter should be mounted at the position higher than the target pipeline, so that the liquid accumulated in the pressure leading pipe is easy to return into the pipeline;

While measuring the flow rate of steam, the differential pressure transmitter should be mounted at the position lower than the target pipeline, thus the pressure leading pipe can be full of condensing water. Something should be

differential pressure transmitter in contact with the medium should be kept not beyond the ultimate operation temperature of the transmitter;

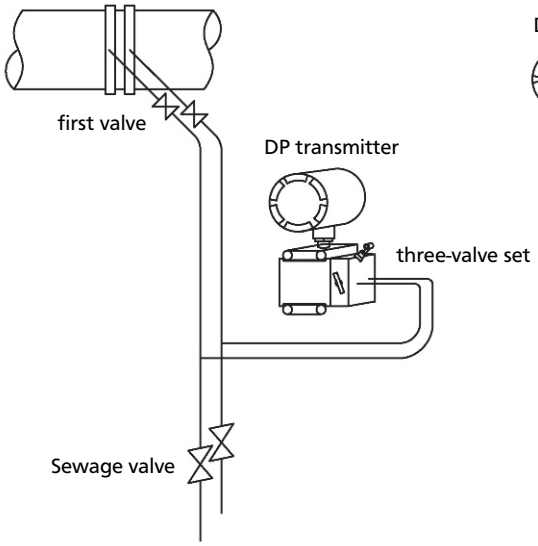
- **Installation requirements on temperature and pressure transmitters**

While measuring the overheat steam medium, the temperature sensor and the pressure transformer must be added to compensate the density; if the saturation steam medium is to be measured, the temperature sensor or the pressure transmitter must be added to compensate the density;

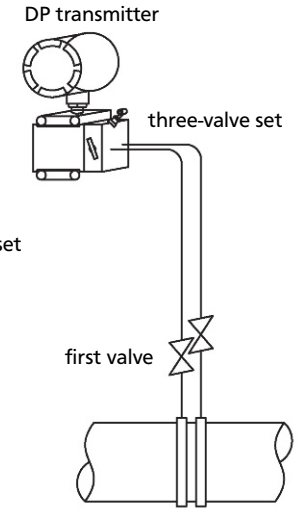
While measuring the natural gas and gas mediums, the pressure transmitter must be added to compensate the density as well as the security grid and transmitter with anti-explosive device should be added;

The temperature sensor is arranged on the target pipeline, and located out of the straight pipe section with 5D at the front of the balanced flow sensor or the straight pipeline section with 2D at the back of the balanced flow sensor; the top end of the temperature probe should be inserted into the part crossing 1/2 of the diasensor of the pipeline so as to ensure the measurement precision;

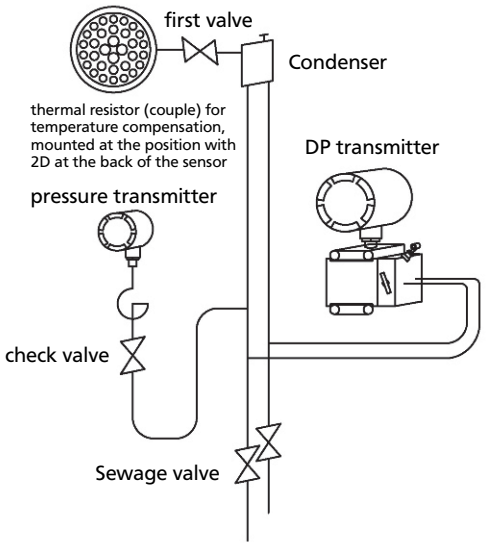
The pressure taking point of the pressure transmitter must be located out of the straight pipe section with 5D at the front of the balanced flow sensor or the straight pipeline section with 2D at the back of the balanced flow sensor, or directly located at the positive pressure side of the differential pressure transmitter; the check valve is mounted at the middle; the installations of the temperature sensor and the pressure transmitter can be executed comply with common rule in principle, thus the requirements of the system can be satisfied.



measuring the flow rate of liquid pipeline



measuring the flow rate of gas pipeline



measuring the flow rate of steam pipeline

Debugging and Operation

When the installation is completed according to the installation principle and program, all the equipment, pipelines, valves, connectors, leads, wiring terminals, signal plugs and the like should be checked whether they are complete, right and firm before debugging the system; the pipeline and equipment should be checked whether there is plugging and leaking; the lead and the signal inserting port should be checked whether there is error connecting, short circuit, broken line, and bad contact and the like; the system can be debugged when the conditions above all pass the checking; the system can be debugged in the steps as follows:

1.The measurement range of the differential pressure transmitter should be set coordinate with that of the nameplate of the balanced flow sensor; relevant flow rate value and parasensor should be set on the flow rate integrating sensor; or the relevant flow rate formula should be configured in DCS.

2.Draining sewage of the pressure leading pipe;

- Close the positive pressure valve and the negative pressure valve at two sides of the three-valve set, and open the balance valve at the middle;
- Completely open the first valves at two sides of the balanced flow sensor;
- Open the positive pressure sewage valve and the negative pressure sewage at two sides of the pressure leading pipe to drain the sewage, and clean the pressure leading pipe.

3. Condensing of pressure leading pipe(Measurement of steam):

• Close the sewage valve; naturally condense the medium in the pressure leading pipe until the whole pipeline is full of condensing water (this process possibly carried out for 4 hours).

• If the pressure leading pipe is full of condensing water, open the positive pressure valve and the negative pressure valve at two sides of the three-valve set (at that time, the balance valve at the middle is still in open state), pour the condensing water into the positive pressure chamber and the negative pressure chamber of the differential pressure transmitter; the condensing water needs some time to deposit, for this reason, the display value of the differential pressure transmitter at the beginning is not precise; when the whole measuring system (including the pressure taking body, the pressure leading pipe, and the positive pressure chamber and the negative pressure chamber of the differential pressure transmitter) is full of the condensing water, the indication of the differential pressure transmitter is close to common value (this process possibly needs 2 hours).

4. Exhausting of differential pressure transmitter(Measurement of liquid and steam):

As the residual air in the positive pressure chamber and the negative pressure chamber of the differential pressure transmitter is to be completely exhausted, the exhausting is carried out on the positive pressure chamber and the negative pressure chamber of the transmitter.

5. Zeroing of differential pressure transmitter:

• Close the exhaust valves on the positive pressure chamber and the negative pressure chamber of the differential pressure transmitter;

• Close the positive pressure valve and the negative pressure valve at two sides of the three-valve set (at that time, the balance valve at the middle is still kept in open state).

6. Measuring flow rate:

Open the positive pressure valve and the negative pressure valve at two sides of the three-valve set, and close the balance valve at the middle to execute measurement.

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