Working principle

The vortex flowmeter operates on the basis of Karman vortex street principle. When the media flows through the vortex generator,the vortex is formed at its two sides in rotation thus forming the vortex street(Karman vortex street).The generating frequency f of vortex street is directly proportional to the flow speed v and is inversely proportional to the width d of vortex generator:

$$f=St \times v / d$$

Instrument parameters: a ratio of separation pulse amount of vortex to the volume amount:

$$K=N / V$$

In the formula: K-instrument coefficient (pulse 1/m3)

N-pulse number (time)

V-volume amount

The relationship between the vortex separation frequency and liquid flow is as follows:

$$f=K \times Q$$

In the formula: f-frequency (time)

Q-flow （m3/h）

By testing the vortex separation frequency, the liquid flow in the pipe can be measured.

◆ Product type and mark

Table 1 Product type and mark

Product type and mark								Instruction
Order 1.2.3	4	5	6	7	8	9	10	
Kind LUG								Karman vortex street
Test method	B							Stress type test
Flange clamp		2						The product exits the factory with the clamp flange and bolts
Media tested			1					For both gas and liquid
			2					Liquid
			3					Gas
			4					Steam
Caliber				02				25mm
				04				40mm
				05				50mm
				08				80mm
				10				100mm
				15				150mm
				20				200mm
				25				250mm
				30				300mm
					Z			Combination type
						P		Voltage pulse(24V power supply)
						S		(4 ~ 20)mA output and on site LCD display (24V power supply)
						D		On site LCD display,without any output(3.6V lithium battery power supply)
							B	Intrinsic explosion proofiaIICT6

Technical parameters

Table 2 Main technical performance of the sensor

Nominal diameter	25/40/50/80/100/150/200/250/300	Output signal	Pulse、(4 ~ 20)mA
Material	1Cr18Ni9Ti	Ambient conditions	(-10 ~ +55)℃
Nominal pressure	Lower than 2.5MPa	Power	+24V
Media temperature	(-40 ~ + 250) (- 40 ~ + 350)℃	Signal transmission wire	RVVP3 × 0.5、RVVP2 × 0.5
Accuracy class	0.5、1.0、1.5	Transmission distance	1000 m
Scope	1：10	Type of safety barrier	JHA－H2 JHA－B
Resistance loss coefficient	Cd lower than2.4		

Product purpose

This instrument can be used widely in the flow measurement of various medium such as drainage, industrial circulation, sewage disposal, oil type and chemical agent, compressed air, saturated steam, over-hot steam and natural gas in the "big, medium or small pipe."

Flow scope(liquid)

Table 3

Caliber	Flow scope（m^3/h）	Caliber	Flow scope (m^3/h)
25	1.6 ~ 13	150	45 ~ 450
40	3 ~ 30	200	80 ~ 800
50	5 ~ 40	250	125 ~ 1200
80	13 ~ 130	300	180 ~ 1800
100	20 ~ 200		

The maximum flow speed of liquid should be lower than 7m/s, the standard liquid means the liquid at the temperature of t=20℃; P = 0.1013MPa; ρ =998kg/m^3.

Flow scope(gas)

Table 4

Caliber	Flow scope（m^3/h）	Caliber	Flow scope (m^3/h)
25	9 ~ 60	150	200 ~ 2000
40	20 ~ 160	200	400 ~ 4000
50	45 ~ 300	250	750 ~ 8000
80	80 ~ 600	300	1000 ~ 10000
100	120 ~ 1000		

The gas means the air under normal temperature and pressure, t=20℃; P=0.1013MPa; ρ = 1.205 kg/m^3.

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Flow range(Saturated steam) kg/h

Table 5-1

Bore (mm)	Pressure (MPa)						
	0.1	0.15	0.2	0.3	0.4	0.5	0.6
DN25	9 ~ 89	13 ~ 129	17 ~ 170	25 ~ 248	29 ~ 324	32 ~ 401	35 ~ 476
DN40	18 ~ 230	26 ~ 335	34 ~ 441	50 ~ 644	58 ~ 842	64 ~ 1041	70 ~ 1236
DN50	24 ~ 295	34 ~ 430	45 ~ 565	66 ~ 825	77 ~ 1080	86 ~ 1335	94 ~ 1585
DN80	59 ~ 708	86 ~ 1032	113 ~ 1356	165 ~ 1980	193 ~ 2592	215 ~ 3204	234 ~ 3804
DN100	89 ~ 1121	129 ~ 1634	170 ~ 2147	248 ~ 3135	290 ~ 4104	322 ~ 5073	361 ~ 6023
DN150	177 ~ 2655	258 ~ 3870	339 ~ 5085	495 ~ 7425	580 ~ 9720	644 ~ 12015	722 ~ 14265
DN200	254 ~ 4720	370 ~ 6880	486 ~ 9040	710 ~ 13200	863 ~ 17280	1067 ~ 21360	1267 ~ 25360
DN250	478 ~ 8260	697 ~ 12040	915 ~ 15820	1337 ~ 23100	1565 ~ 30240	1740 ~ 37380	1949 ~ 44380
DN300	832 ~ 11800	1213 ~ 17200	1593 ~ 22600	2327 ~ 33000	2724 ~ 43200	3092 ~ 53400	3300 ~ 63400
Density(kg/m^3)	0.59	0.86	1.13	1.65	2.16	2.67	3.17
Temperature(℃)	99.6	111.4	120	133	144	152	159

Table 5-2

Bore (mm)	Pressure (MPa)					
	0.7	0.8	0.9	1.0	1.2	1.5
DN25	38 ~ 551	40 ~ 624	43 ~ 699	45 ~ 773	49 ~ 920	54 ~ 1140
DN40	76 ~ 1431	80 ~ 1622	85 ~ 1817	89 ~ 2009	99 ~ 2391	122 ~ 2964
DN50	101 ~ 1835	107 ~ 2080	114 ~ 2330	119 ~ 2575	130 ~ 3065	145 ~ 3800
DN80	252 ~ 4404	268 ~ 4992	284 ~ 5592	298 ~ 6180	329 ~ 7365	408 ~ 9120
DN100	418 ~ 6973	474 ~ 7904	531 ~ 8854	586 ~ 9785	698 ~ 11647	865 ~ 14440
DN150	836 ~ 16515	947 ~ 18720	1061 ~ 20970	1173 ~ 23175	1396 ~ 27585	1730 ~ 34200
DN200	1467 ~ 29360	1663 ~ 33280	1863 ~ 37280	2058 ~ 41200	2450 ~ 49040	3038 ~ 60800
DN250	2256 ~ 51380	2557 ~ 58240	2865 ~ 65240	3166 ~ 72100	3768 ~ 85820	4672 ~ 106400
DN300	3551 ~ 73400	3780 ~ 83200	4001 ~ 93200	4269 ~ 103000	5081 ~ 122600	6300 ~ 152000
Density(kg/m^3)	3.67	4.16	4.66	5.15	6.13	7.60
Temperature(℃)	165	170	175	180	188	234

Table 5-3

Bore (mm)	Pressure (MPa)				
	2.5	3.0	3.5	4.0	4.5
DN25	78 ~ 1875	94 ~ 2250	109 ~ 2625	125 ~ 3000	141 ~ 3401
DN40	201 ~ 4875	241 ~ 5850	282 ~ 6825	322 ~ 7800	365 ~ 8841
DN50	208 ~ 6250	249 ~ 7500	291 ~ 8750	333 ~ 10000	377 ~ 11335
DN80	671 ~ 15000	805 ~ 18000	939 ~ 21000	1073 ~ 24000	1217 ~ 27204
DN100	1423 ~ 23750	1708 ~ 28500	1992 ~ 33250	2277 ~ 38000	2581 ~ 43073
DN150	2846 ~ 56250	3415 ~ 67500	3984 ~ 78750	4554 ~ 90000	5162 ~ 102015
DN200	4996 ~ 100000	5995 ~ 120000	6995 ~ 140000	7994 ~ 160000	9061 ~ 181360
DN250	7684 ~ 175000	9221 ~ 210000	10758 ~ 245000	12295 ~ 28 × 10^3	13936 ~ 317380
DN300	10361 ~ 25 × 10^4	12434 ~ 3 × 10^5	14506 ~ 35 × 10^4	16578 ~ 4 × 10^5	18791 ~ 453400
Density(kg/m^3)	12.50	15.00	17.5	20.00	22.67
Temperature(℃)	224	234	242	250	258

Flow range(over-hot steam t/h)

Table 6

Caliber	Minimum flow	Maximum flow	Caliber	Minimum flow	Maximum flow
25	14.063 ρ $^{1/2}$ kg/h	70.681 ρ kg/h	150	506.31 ρ $^{1/2}$ kg/h	2.5445 ρ
40	36.005 ρ $^{1/2}$ kg/h	180.94 ρ kg/h	200	0.90012 ρ $^{1/2}$ kg/h	4.5236 ρ
50	56.257 ρ $^{1/2}$ kg/h	282.73 ρ kg/h	250	1.4064 ρ $^{1/2}$ kg/h	7.0681 ρ
80	144.02 ρ $^{1/2}$ kg/h	723.77 ρ kg/h	300	2.0253 ρ $^{1/2}$ kg/h	10.178 ρ
100	225.03 ρ $^{1/2}$kg/h	1.1309 ρ			

The density of over-hot steam under working condition P, kg/m^3

The installation of vortex street flow sensor

◆ Choose the installation point correctly

It is very important to select an installation point and properly install the sensor.In case of any improper installation, it can either influence measurement accuracy or the service lifetime, or even damage the sensor.

(For easy installation and detachment, an expansion joint can be added behind the flow meter.)

◇ Requirement for straight tube

There is requirement for straight tubes on the upper and lower stream of sensor's installation point,or the measurement accuracy will be influenced.If there is a gradual shrinkage tube at the upper stream of sensor's installation point, there should be a straight tube no less than 15D at the upper stream and a straight tube no less than 5D at the lower stream of sensor.

If there is a gradual expansion tube at the upper stream of sensor's installation point, there should be a straight tube no less than 18D at the upper stream and a straight tube no less than 5D at the lower stream of sensor.

If there is a 90° bend or T joint at sensor's installation point, there should be a straight tube no less than 20D at the upper stream and a straight tube no less than 5D at the lower stream of sensor.

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If there are two 90° bends of the same plane at upper stream of sensor's installation point, there should be a straight tube no less than 25D at the upper stream and a straight tube no less than 5D at the lower stream of sensor.
If there are two 90° bends of different plane at upper stream of sensor's installation point, there should be a straight tube no less than 40D at the upper stream and a straight tube no less than 5D at the lower stream of sensor. Try to install the flow regulate valve or pressure regulate valve at 5M away from the sensor's lower stream.
If it is necessary to locate it at the upper stream, there should be a straight tube no less than 50D at the upper stream and a straight pipe no less than 5D at the lower stream of sensor.

◆ Special cautions

If the valve is close to the upper stream of sensor's installation point, constantly turning on\off the valve will greatly influence lifetime and easy to bring permanent damage to sensor.
Avoid to install valve at the long pipes built on the stilts , otherwise , the lower part to sensor can easily cause sealing leakage between sensor and flange. If it is impossible to avoid, it is required to prepare fixing devices at the 2D of sensor's lower stream

◆ Requirement for pipes

There are some requirements for straight tubes at both upper and lower stream of sensor's installation point. Or the measurement accuracy will be influenced.
Pipes at both upper and lower stream of sensor's installation point have the same inner diameter as that of sensor, which should meet the following requirement:

□ $0.98DN \leqslant D \leqslant 1.05D$

In the formula:DN-inner diameter of sensor; D-inner diameter of pipes.
Pipes should be concentric with sensor and the axial should not be over 0.05DN ;
The sealing gasket between sensor and flange cannot be protruding inside pipes , its inner diameter can be slightly bigger than that of sensor.

◆ Requirement for bypass

It is better to prepare bypass for maintenance and repair. Besides, if it is impossible to stop supplying fluid for purpose of maintenance and repair at the tubes to be cleaned or at sensor 's inner pipes, it is necessary to install bypass and ensure straight tubes at both front and back ends.

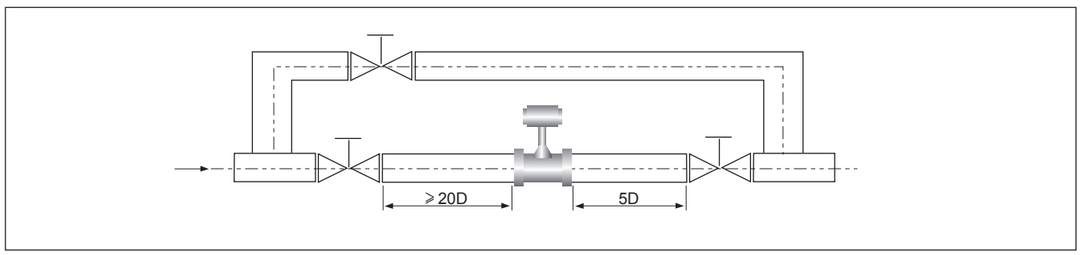

Fig.1

◆ Requirement for pipe vibration

Avoid to install sensor at tubes with strong vibration; In case of impossible avoidance, it is required to have vibration reduction measures, such as : preparing fixing devices at 2D of sensor's upper and lower stream and adding antivibration gasket. Special attention: Avoid to install sensor at the outlet of air compressor and try to put after the storage tank.

◆ Requirement for outer environment

1) Avoid to install at places which have great temperature changes or under heat radiation, in case of such conditions, it is required to have ventilation and heat insulation measure.
2) Avoid to install at places which have corrosive gases, in case of such conditions, it is required to have ventilation measure.
3) It is better to install inside room,in case of outdoor, it is required to have anti-damp and anti-basking measure and prevent water from flowing along cables into the amplifier box.
4) There should be enough space around the sensor, with lighting and power socket for wiring and constant maintenance.
5) The wiring box of sensor should be away from electric noise, such as: large power transformer, motor and power etc.
6) There should be no wireless receiver and sender near the sensor,or high frequency noise will interfere with normal operation of sensor.

◆ To install correctly

While measuring gas flow, if there is a little liquid contained in the gas measured, sensor should be placed at a higher point of pipes.
While measuring liquid flow, if there is a little gas contained in the liquid measured, sensor should be placed at a lower point of pipes.

◇ Install sensor at the vertical pipes

While measuring gas flow, sensor can be placed at vertical pipes without any limitation of flow direction.if there is a little liquid contained in the gas measured , the gas flow direction should be from up to down.
While measuring liquid flow, liquid flow direction should be from downward to upward in order to avoid additional liquid weight on probes.

◇ Install sensor at the side of horizontal pipes

No matter what kind of fluid is measured, sensor can be installed at the side of horizontal pipes, especially while measuring the over-heated steam , saturated steam and low-temperature liquid,it is better to take horizontal installation if possible in order to minimize temperature's influence on amplifier.

◇ Install downwards at the horizontal pipes

Usually it is not recommended, such method isn't applicable for measuring gas and over-heated steam,but it is good for measuring saturated steam and high temperature liquid,or tubes requiring frequent cleaning.

◇ Install sensor at the heat-protection pipes

While measuring high temperature steam, use heat insulation materials to wrap the surrounding pipes for heat protection. Under such circumstances, avoid wrapping sensor's connection rod at max. 1/3 of its height with heat insulation material, however, sensor's housing can be wrapped.

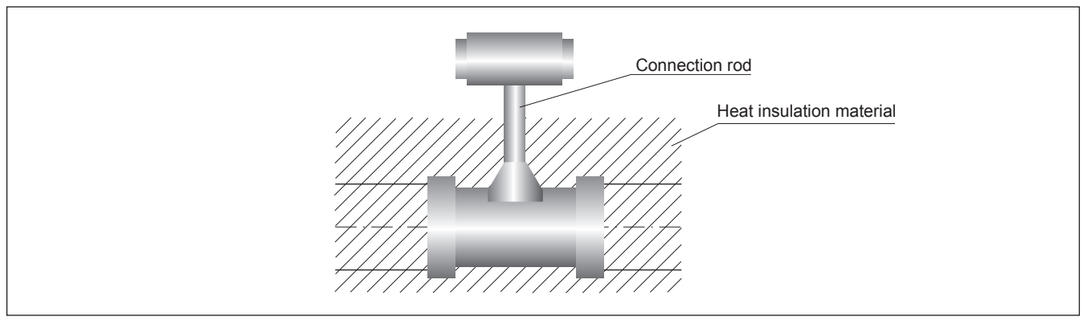

Fig.2

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◇ Installation procedures of sensor and pipes

The instrument uses flange connection (butt or holding type), tighten screws and clamp sensor with 2 flanges, flange's protruding part clamps sensor and concave part shares the tubes , see the following procedures:

a) Calculate the installation dimension.

b) Saw off the pipes to be installed and repair the cut.

c) Cover flange on the pipes, fix and spot weld , then weld the whole ring , check if it is well welded.

d) Repeat the am. steps and weld another side of flange.

e) Take the welded pipes to the installation site and combine it with sensor , then install on the pipes.

f) Check if every procedure is well done; slowly open the valve , check if there is any leakage.

◇ Special attention:

a) Flow direction should be the same as the flow indication of sensor.

b) During installation, while welding flange or pipes, sensor should not be on the pipes to avoid damage to the electric amplifier circuit.

c) Flanges at both side of sensor should be in parallel to avoid any possible leakage.

◇ On site wiring of output frequency signal

3-phase transmission is adopted between flowmeter which outputs frequency signal and other equipments, the necessary power is 24(1±10%) V, the minimum load resistance of output circuit is 10KΩ, maximum capacitor is 0.22uF and the shielding resistance must be less than 50Ω.

Usually, 3-phase wiring is adopted(RVVP3X 0.5mm).The shielding layer can be connected to the ground nut of amplifier box; under high and low temperature, it is necessary to use shielding wiring appropriate for the local temperature.

If there is oil, solvent or other corrosive gas and liquid in the on site air, it is necessary to use shielding wiring appropriate for the local conditions.

Wiring cannot be in parallel with the power line, it needs at least 15cm space, better to be inside the metal tubes . Fix the wiring and prevent any shaking.

◆ Select correctly temperature and pressure measuring point

While measuring pressure and temperature near sensor, the pressure measuring point should be 3D-5D of the lower stream of the sensor, and temperature measuring point should be behind the pressure measuring point.

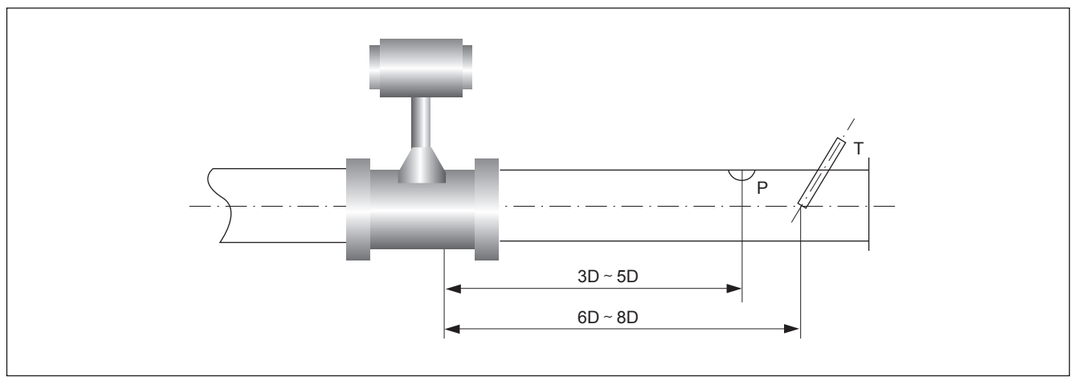

Fig.3

◆ Outer dimension of flowmeter and schematic diagram of installation

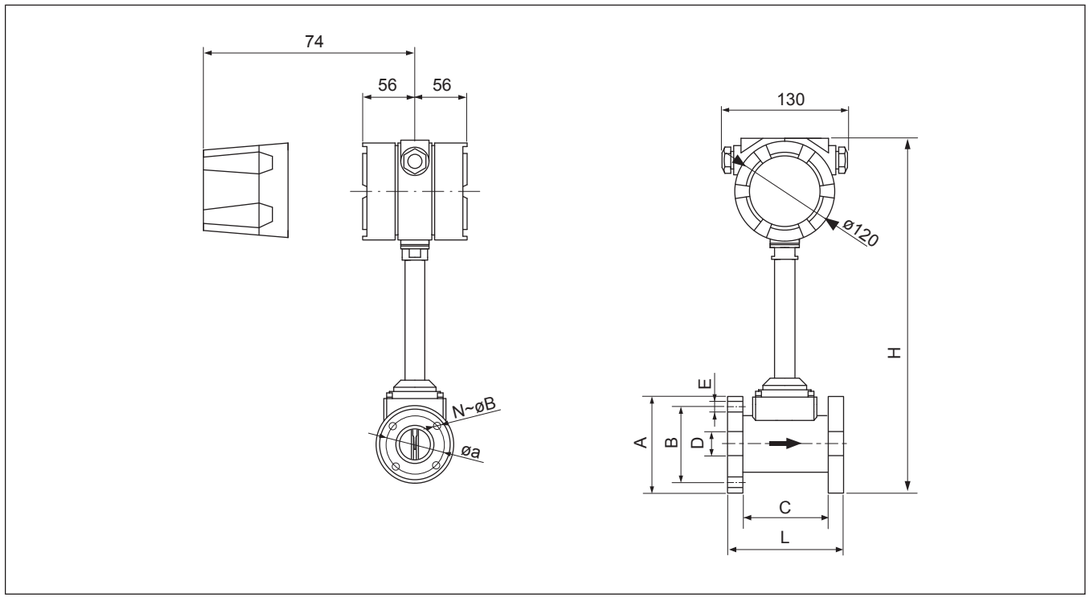

Fig.4

◆ The installing dimensions

Table 7

Bore DN	Instrument dimension			Flange dimension			
	C	L	H	A	B	D	E
25	70	102	360	145	118	16	4- Ø16
40	82	114	340	140	110	16	4- Ø18
50	82	122	350	160	130	20	4- Ø18
65	92	146	380	185	145	22	4- Ø18
80	110	150	385	198	160	20	6- Ø18
100	120	164	410	232	190	22	6- Ø18
150	142	190	460	280	240	24	8- Ø24
200	170	222	520	340	295	26	12- Ø24
250	170	226	585	405	355	28	12- Ø28
300	170	234	640	460	410	32	12- Ø28

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