ANF382 Vortex Flowmeters

Operating Principle

The ANF382 vortex flowmeter measures the flow rate of steam, gases and low-viscosity liquids based on Carmen and Strohar's theory of vortex generation and vortex and flow relationship. As shown in Figure 1, a triangular column is vertically inserted into the table body, that is, the generator of the vortex, when there is a medium flowing through the table body, a regular Carmen vortex with opposite direction is alternately generated behind the triangular column, and the separation frequency F of the vortex is proportional to the flow velocity V of the medium. The number of vortexes detected by the sensor head can measure the fluid flow rate, and then the volume flow rate of the measured medium can be calculated according to the diameter of the gauge body.

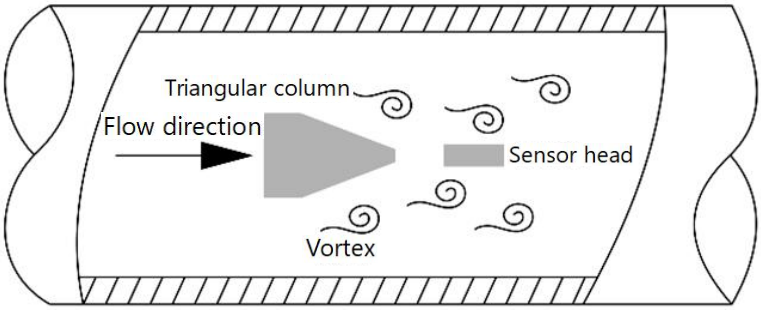

Figure 1

The calculation formula is as follows:

$F=Sr\times V/(1-1.27\times d/D)$ ……Equation 1

$Q=3600\times F/K$ ……Equation 2

$M=Q\times p$ ……Equation 3

- F……Vortex frequency generated by fluid flowing through a vortex triangle (unit:Hz)
- Sr……The Strohal number (unit: dimensionless)
- V……Flow rate of fluid in pipe (unit :m/s)
- d……Width of triangular column inside the vortex surface (unit: m)
- D……Inner diameter of vortex street (unit: m)
- Q……Instantaneous volume flow (unit: m^3/h)
- K……Gauge coefficient of vortex street (unit: number of pulses / cubic meter)
- M……Instantaneous mass flow rate (unit: kg/h)
- p……Fluid density (unit: kg/m^3)

The vortex flow sensor of different calibers, the instrument coefficient K value is different, and its specific value is obtained by the actual calibration of the flow calibration device. The meaning is the number of pulses produced per cubic meter. That is, the number of vortices generated by flowing through one side of a cubic meter of fluid triangular column.

Specifications

Measuring Media		**Gas, Liquid, Steam**
Diameter	**Flange clamping Type**	DN15mm ~ DN300mm(customized is available beyond this range)
	Flange Pipe Type	DN15mm ~ DN300mm(customized is available beyond this range)
	Plug-in type	DN150mm ~ DN3000mm(customized is available beyond this range)
Range	**Velocity Range**	Gas/Steam:4 ~ 40m/s Liquid：0.5~5m/s
	Flow Range	The measuring range of liquid and gas flow is shown in Table 1. The saturated steam flow range is shown in Table 2. The plug-in flow range is shown in Table 3
Accuracy		Flange clamping type, flange type for class 1 and class 1.5
		The precision of the insert measuring head is class 1, and the precision of the insert industrial tube is class 2.5.
Temperature of the measured medium		Normal temperature: -25℃ ~100℃, Medium temperature: -25℃ ~250℃, High temperature: -25℃ ~350℃
Nominal Pressure		1.6Mpa；2.5Mpa；4.0Mpa (customizable)
output signal (interface is M20x1.5 internal thread)	**Pulse Voltage Output Signal**	High level 8~10V, low level 0.7~1.3V
		Pulse duty cycle is about 50%, transmission distance is 100 meters
	Standard Voltage Output Signal	DC4~20mA allows the external load resistance to be less than 600Ω (power supply 24V), and the transmission distance is 100 meters
Instrument usage environment		Temperature: -25℃ ~+55℃, Humidity: 5~90%RH (50℃)
Material		Body is 304 stainless steel, the converter housing is aluminum alloy and 316 stainless steel body needs to be customized.
Power supply		DC12V±10%；DC24V±10%；Lithium battery 3.6V 7.5Ah*2
Protection Class		IP65

Determination of flowmeter diameter and available flow range

(1) Gas and liquid

The upper limit flow rate of a vortex flowmeter is generally not affected by medium pressure, temperature, etc., while the lower limit flow rate depends on the working condition density and viscosity of the medium. Therefore, determining the flow range is actually determining the actual available lower flow rate. The optimal working flow is at 1/2-2/3 of the sensor range.

Step 1: Preliminarily determine the flow meter diameter based on the actual flow rate table 3. Commonly used traffic should be selected at 50%-70% of the traffic limit. Note that the gas is Refers to the working condition flow. If it is the standard condition flow, please use equation (3) to convert it into the working condition flow.

$Q=Q_N x(P_N/P)x(T/T_N)$ (3):

Q–working flow rate;

Q_N- standard flow rate;

P_N--standard atmospheric pressure (0.101325MPa);

P–absolute pressure of the medium under working conditions (gauge pressure + atmospheric pressure);

T–absolute temperature of medium under working conditions [(273.15+t) K];

t–Medium temperature under working conditions (℃);

T_N - standard absolute temperature (273.15K).

Step 2: Calculate the lower limit flow rate determined by the medium working condition density according to equation (4) Q_P。

Clamp connected vortex flowmeter

Qp =Q0×$\sqrt{\rho_0 / \rho}$ (4)

QP-- The measurable lower limit flow rate of the medium under the working density;

Q0-- The lower limit flow rate of water or air listed in the table (Liquid check water, gas check air);

ρ0-- The density of the reference medium is 1000kg/m³ for water and 1.205kg/m³ for air;

ρ-- The working condition density of the measured medium.

When the medium density is high, the lower measurable flow rate is lower.

Step 3: Calculate the lower limit flow determined by the kinematic viscosity of the medium working condition according to Equation (5) quantity QV。

QV=Q0 x u/u0 (5)

QV-- The measurable lower limit flow rate of the medium under the kinematic viscosity of the working condition;

Q0-- The lower limit flow rate of water or air listed in Table 3 (Liquid check water, gas check air);

u-- Kinematic viscosity of the medium being measured;

u0-- Kinematic viscosity of the reference medium, water is 1x10-6 m2/s, air is 15x10-6 m2/s.

Vortex flowmeter with external thread connection

The conversion formula between kinematic viscosity and dynamic viscosity is as follows:

u=η/ρ (6)

u-- Kinematic viscosity (m2/s);

η-- Dynamic viscosity [kg/(m . s)];

ρ-- Density (kg/m3)。

When the kinematic viscosity of the medium is small, the lower measurable flow rate is lower.

Step 4: Compare QP and QV to determine the available lower limit flow rate and linear lower limit flow rate. If QP < QV, the measurable flow range is QP ~ Qmax, and the linear flow range is QP ~ Qmax; if QP ≥ QV, the measurable flow range and linear flow range are both QP ~ Qmax. Qmax refers to the upper limit flow rate specified in Table 3. The maximum flow velocity of liquid should generally be less than 10m/s, and the maximum flow velocity of gas should generally be less than 70m/s. The linear lower limit flow rate of high-viscosity liquids is much higher than that of water. If a lower lower limit flow rate is required, a vortex flowmeter is not suitable.

(2) Steam

When the user's measurement medium is steam, the mass flow measurement unit is commonly used, such as t/h or kg/h. Since steam has different densities at different temperatures and pressures, the steam flow range can be calculated by equation (7).

Step 1: Find out the air flow range of the corresponding caliber flow meter from Table 3.

Step 2: According to the pressure and temperature parameters of the steam, check the relevant information to obtain the density of the steam.

Step 3: Calculate the lower limit flow rate of the flow meter according to equation (7).

Flange clamping compensated vortex flowmeter

Q=1.5Q0×$\sqrt{\rho_0 / \rho \times \rho}$(kg/h) (7)

Q, ρ--the flow rate and density of the steam being measured;

Q0, ρ0--Flow rate and density of reference air (1.205kg/m3).

Step 4: Determine the upper limit of traffic. The upper limit flow velocity of steam should be less than 70m/s. Users can also check Table 4 to learn the flow range of saturated steam measured by flow meters of different calibers, or substitute the density of superheated steam into Table 5 to calculate the flow range of superheated steam measured by flow meters of different calibers. When measuring the mass flow of steam, the sensor must be combined with the temperature and pressure measuring element.

Make up a mass flow measurement system. To measure saturated steam, a platinum resistor or pressure transmitter should be installed; to measure superheated steam, both a platinum resistor and a pressure transmitter should be installed.

Measuring range

(1) Flow range of liquid and working gas

Table 1

Diameter (mm)	Liquid	Normal Temperature and Pressure Air
	Standard Measuring Range (m³/h)	Standard Measuring Range (m³/h)
15	0.8~6	6~40
20	1~8	8~ 50
25	1.5~12	10~ 80
32	2~16	14~ 100
40	2.5~30	25~200
50	3~50	30~300
65	5~80	50~500
80	8~120	80~800
100	12~200	120~1200
125	20~300	160~1600
150	30~400	250~2500
200	50~800	400~4000
250	80~1200	600~6000
300	100~1600	1000~10000
400	200~3000	1600~16000
500	300~5000	2500~25000
600	800~8000	4000~40000

(2) Mass flow range of saturated steam (kg/h)

Table 2

Absolute Pressure P(MPa)	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.5	2.0
Temperature t(℃)	120.23	133.54	143.62	151.84	158.94	164.96	170.41	175.36	179.88	187.96	198.41	212.37
Density ρ(kg/m³)	1.129	1.651	2.163	2.669	3.170	3.667	4.162	4.655	5.147	6.127	7.602	10.05
DN25 lower limit standard	14	17	19	22	23	25	27	28	30	33	36	42
DN25 upper limit standard	140	170	190	220	230	250	270	280	300	330	360	420
DN32 lower limit standard	26	30	34	38	41	44	47	50	52	57	63	73
DN32 upper limit standard	260	300	340	380	410	440	470	500	520	570	630	730
DN40 lower limit standard	31	38	44	48	53	57	60	64	67	73	82	94
DN40 upper limit standard	310	380	440	480	530	570	600	640	670	730	820	940
DN50 lower limit standard	52	63	73	81	88	95	101	107	112	122	136	157
DN50 upper limit standard	520	630	730	810	880	950	1010	1070	1120	1220	1360	1570
DN65 lower limit standard	90	106	121	134	146	158	168	178	187	204	227	261
DN65 upper limit standard	900	1060	1210	1340	1460	1580	1680	1780	1870	2040	2270	2610
DN80 lower limit standard	122	148	170	188	205	221	235	249	261	285	318	365
DN80 upper limit standard	1220	1480	1700	1880	2050	2210	2350	2490	2610	2850	3180	3650
DN100 lower limit standard	175	212	242	269	293	315	336	355	374	408	454	522
DN100 upper limit standard	1750	2120	2420	2690	2930	3150	3360	3550	3740	4080	4540	5220
DN125 lower limit standard	262	318	363	404	440	473	504	533	561	612	681	783
DN125 upper limit standard	2620	3180	3630	4040	4400	4730	5040	5330	5610	6120	681	783
DN150 lower limit standard	350	423	484	538	586	631	672	711	747	815	908	1044
DN150 upper limit standard	3500	4230	4840	5380	5860	6310	6720	7110	7470	8150	9080	10440

DN200 lower limit standard	700	846	969	1079	1173	1261	1344	1421	1494	1630	1815	2088
DN200 upper limit standard	7000	8460	9690	10790	11730	12610	13440	14210	14940	16300	18150	20880
DN250 lower limit standard	1050	1269	1453	1641	1759	1892	2016	2132	2241	2445	2722	3132
DN250 upper limit standard	10500	12690	14530	16410	17590	18920	20160	21320	22410	24450	27220	31320
DN300 lower limit standard	1750	2116	2422	2690	2932	3153	3359	3553	3736	4076	4536	5220
DN300 upper limit standard	17500	21160	24220	26900	29320	31530	33590	35530	37360	40760	45360	52200

(3) The mass flow range of superheated steam

表 3

Diameter (mm)	Lower Limit Flow (kg/h)	Upper Limit Flow (kg/h)	Diameter (mm)	Lower Limit Flow (kg/h)	Upper Limit Flow (kg/h)
25	13.1 $\sqrt{\rho}$	131 、	100	164.7 、	1647 、
32	23.0 $\sqrt{\rho}$	230 、	125	247.1 、	2471 、
40	26.5 $\sqrt{\rho}$	265 、	150	329.4 、	3294 、
50	49.4 $\sqrt{\rho}$	494 、	200	658.8 、	6588 、
65	82.3 $\sqrt{\rho}$	823 、	250	988.2 $\sqrt{\rho}$	9882 、
80	115.3 、	1153 $\sqrt{\rho}$	300	1647 $\sqrt{\rho}$	16470 、

Note:

1. ρ is the working condition density of superheated steam. The upper limit flow rate of superheated steam should generally not be greater than 70m/s.

2. The pressure loss of the sensor under different flow rates can be calculated as follows:

$$\triangle P=1.2\rho V^2 :$$

$\triangle$ P-- pressure loss (Pa);

ρ-- Working condition density of measured medium (kg/m³);

V-- Average flow velocity in the tube (m/s)。

3.When the measured medium is liquid, in order to prevent vaporization or cavitation, the absolute pressure in the sensor under working conditions should meet the following requirements:

$$P>2.6 \triangle P+1.25P_b:$$

P-- Absolute pressure of measured medium (Pa);

P_b-- Corresponding absolute pressure of saturated gas at the working temperature of the measured medium (Pa)

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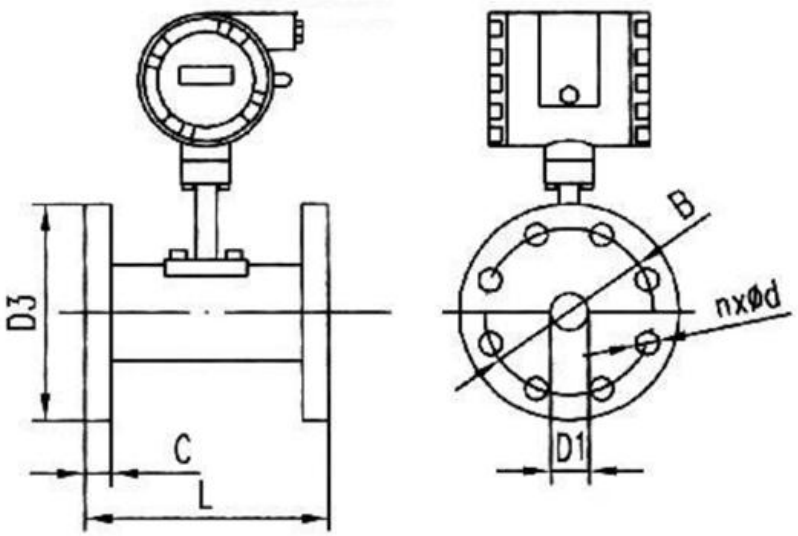
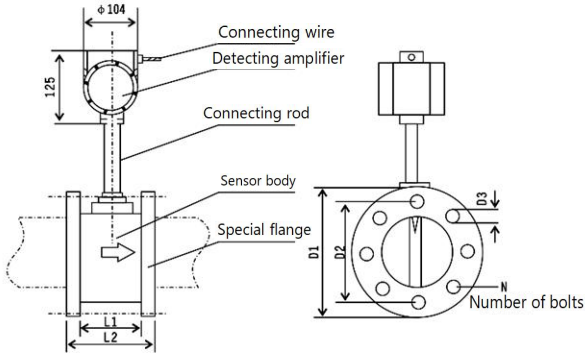
Instrument Structure and Dimensions



Flange pipe type vortex flowmeter dimensions

Flange connection overall dimensions

Diameter(mm)	Body Outer diameter D1(mm)	Body length L(mm)	Flange Outer Diameter D3(mm)	Bolt Center Hole Distance B(mm)	Flange Thickness C(mm)	Diameter of Bolt Hole d(mm)	Bolt Quantity
15	15	170	95	65	14	14	4
20	20	170	105	75	16	14	4
25	25	170	115	85	16	14	4
32	32	170	140	100	18	18	4
40	40	190	150	110	18	18	4
50	50	190	165	125	20	18	4
65	65	220	185	145	20	18	4
80	80	220	200	160	20	18	8
100	100	240	220	180	22	18	8
125	125	260	250	210	22	18	8
150	150	280	285	240	24	22	8
200	200	300	340	295	26	22	12
250	250	360	405	355	28	26	12
300	300	400	460	410	32	26	12

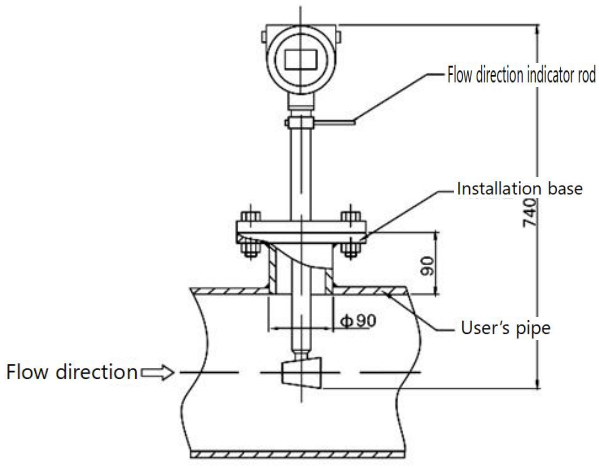


Flange mounted vortex flowmeter dimensions diagram

Flange Clamping dimensions:

口径	L1	L2	D1	D2	D3	N
15	65	95	125	100	13	4
20	65	95	125	100	13	4
25	65	95	125	100	13	4
32	66	96	140	100	13	4
40	80	114	145	110	13	4
50	80	114	160	125	17	4
65	93	136	180	145	17	6
80	100	142	195	160	17	6
100	126	168	230	190	17	8
125	146	192	245	210	17	8
150	166	216	280	240	21	8
200	196	246	335	295	21	12
250	114	168	405	355	21	12
300	130	184	460	410	21	12

External thread connection vortex flowmeter



Insert vortex flowmeter dimensions and installation diagram

The plug-in vortex flowmeter is mainly used for the flow measurement of large-diameter gas, liquid and steam medium in industrial pipelines in various industries. It is characterized by simple structure, no moving mechanical parts, small pressure loss, wide range ratio, range of 10~15, and high cost performance.

•Things to note during installation:

1. The part of the installation base inserted into the pipe must not exceed the inner wall of the pipe;
2. The position of the base on the pipeline should be straight and not skewed;
3. Remove burrs and welding slag;
4. The flange plane of the base is parallel to the axis of the pipeline;
5. Ensure that the medium flow direction is consistent with the flow direction indicator rod. It is strictly forbidden to pull the flow direction indicator rod.

Sensor selection

The model of the stress vortex flow sensor is expressed as ANF382-XXXX-X

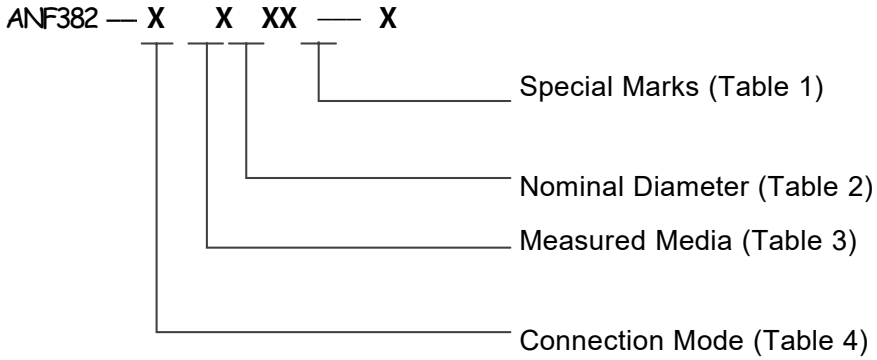


Table 1:Special Marks

Form	Display	Pulse Output	Current Output	Temperature Compensation	Pressure Compensation	Communication	High Temperature
Tag No.	X	M	L	W	Y	T	G

Table 2: Nominal Diameter

Flange pipe type and flange clamp type

Diameter	15	20	25	32	40	50	65	80	100	125	150	200	250	300
Tag No.	00	01	02	03	04	05	06	08	10	12	15	20	25	30

Plug-in Type

Diameter	100	125	150	200	250	300	350	400	450	500	600	700	800	900	1000	1200	1400	1600	1800	2000
Tag No.	10	12	15	20	25	30	35	40	45	50	60	70	80	90	100	120	140	160	180	200

Table 3: Measured Media

Measured Medium	Liquid	General Gas	Saturated Steam	Superheated Steam	Other
Tag No.	1	2	3	4	5

Table 4: Connection Mode

Connection Type	Flange Clamping Type	Flange Type	Plug-in Type	Clamp Type	Threaded Type
Tag No.	1	2	3	4	5