■ Working Principle

Non-streamline vortex-maker be set in fluid(anti-flow part),then two regular vortex would be come out,from two sides of the vortex-maker in turn,so this kind of vortex be called as Karman vortex street,Fig.1 as follow.

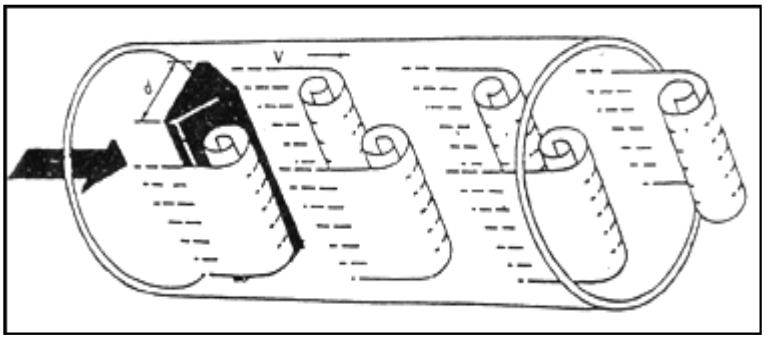


Fig.1

Vortex is not flowing symmetrically under vortex-maker set.As if,set frequency of vortex is f,the speed of test medium is V,inlet face width of vortex-maker is d,Past part diameter is D,as the principle of Karman vortex street,as follow:

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

In the formula:

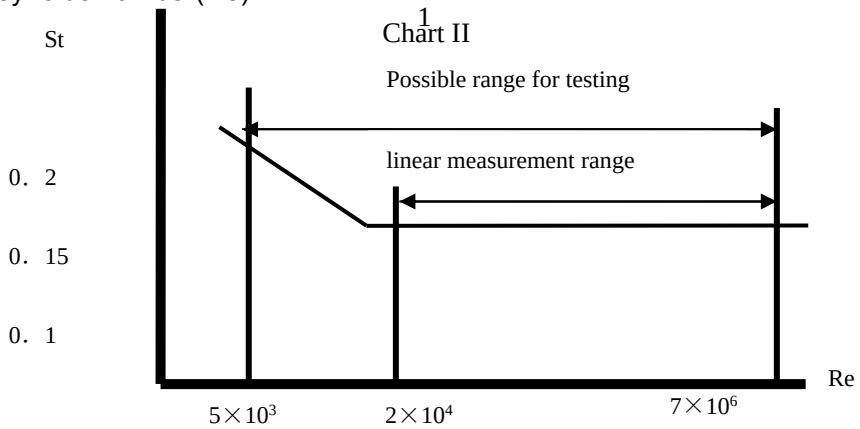
St-Jack straw Hal number;

f-frequency product by single side vortex;

v-flowrate;

d-diameter.

So,check the separate frequency of Karman vortex street to know the instant capacity(flow).among,Strouhal number(St)is dimensionless number,Chart II Show the relation of,Strouhal number(St)&Reynolds number(Re)



Straightness part in curve(St=0.17),free frequency & flow rate of vortex is direct ratio,it means flow sensor range.So just check out frequency (f),we can get the flow rate inside pipe,then as the flow rate(V)to take volume flow,the ratio record of impulse& volume,called as(K),as following:

$$K=N/Q\ (1/m^3)$$

Model：K＝instrument constant(1/m³).

N＝impulse number

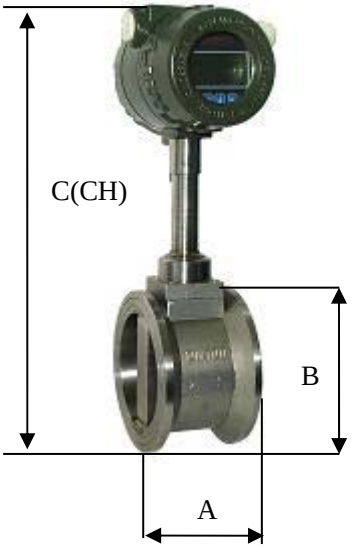
Q＝volume flow(m³)

■ Technical Parameter

Nominal diameter (mm)	25,40,50,65,80,100,125,150,200,250,300,(300～1000 plug-in)
Nominal pressure (MPa)	DN25-DN200 4.0(>4.0 order by agreement),DN250-DN300 1.6(>1.6 order by agreement)
Medium temperature (℃)	Piezoelectric type:-40～260,-40～320; capacitance:-40～300, -40～400,-40～450(order by agreement)
Body material	1Cr18Ni9Ti,(order by agreement if need other material)
Vibrating acceleration	Piezoelectric type:0.2g capacitance:1.0～2.0g
Accuracy	±1%R,±1.5%R,±1FS;plug-in:±2.5%R,±2.5%FS
Range ratio	1:6～1:30
Power voltage	Sensor:+12V DC,+24V DC;transmitter:+12V DC ,+24V DC;battery supply feed:3.6V battery
Output signal	Square wave pulse (non- battery supply feed):high level≥5V,low level≤1V,current:4～20mA
Pressure loss coefficient	JB/T9249 Cd≤2.4
Explosion-proof sign	Intrinsic safety type:Exd Ⅱia CT2-T5; Explosive-proof type:Exd Ⅱ CT2-T5
Enclosure degree	Normal type IP65; water-proof type IP68
Environment condition	Temp 20℃～55℃;relative humidity 5%～90%;atm press 86～106kPa
Medium	Gas,liquid,steam
Transmission range	Three-wire system flow sensor:≤300m,electric sign of two-wire system transmitter (4～20mA):load resistance≤750Ω

■ Outline Size

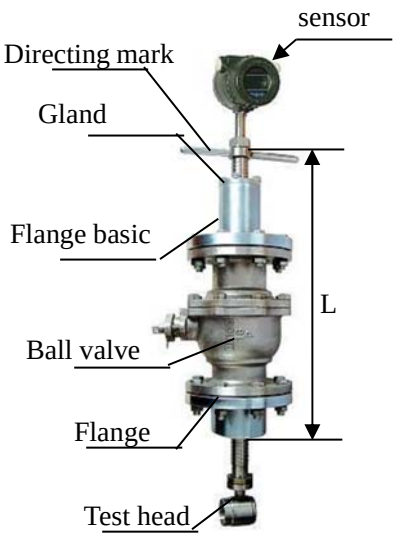
◆Full Package Type Installing Size



caliber（mm）	A	B	C	C_H
15~25	70	55	390	455
40	85	80	385	440
50	85	90	390	450
65	85	105	400	470
80	90	120	420	480
100	85	140	440	500
125	95	168	465	530
150	100	194	490	560
200	102	248	545	610
250	115	300	600	660
300	130	350	650	710

◆Plug-in Type Installing Size

Ball valve & plug-in vortex street meter for installing of location dimension



DN(mm)	DN250	DN300	DN400	DN500	DN600	DN800-2000
L	60.5	58	65.5	60.5	55.5	45.5

■ Steps of Type Selection

It is important for selecting model,which have influence in operation.So the users must pay more attention to the details as following:

Ⅰ.Ensure the diameter of meter

According to the flow range to choose diameter.Different diameter hold different test range.Even if the same diameter,the test range is different if medium is not same. Practical test range must be confirmed by figure.

Flow range of air and water under reference condition,as chart II,reference condition as follow:

1.Air:Normal Temp&press,t=20℃,P=0.1MPa(absolute pressure),ρ=1.205kg/m^3,u=15×10^{-6} m^2/s.

2.Liquid:normal temperature water t=20℃,ρ=998.2kg/m^3,u=1.006×$10^{-6}$$m^2$/s.

Ⅱ.Basic step to ensure diameter of meter and flow range:

1.working parameter clearly.

（a）name & component of testing medium

（b）Min, Nor and Max capacity under working condition

（c）Min, Nor & Max Press & Temp of medium

（d）viscosity of medium under working condition

2.Meter test the flow capacity of medium under working condition,so as the technological parameter to know the flow capacity of medium under working condition,as follows:

（a）if know air capacity under standard condition,we can get the capacity which under working condition,as follow:

$$Q_v = Q_O \times \frac{0.131025}{0.101325 + P} \times \frac{273.15 + t}{293.15}$$ formula（3）

(b)if know air density under standard condition ρ,as follow:

$$\rho = \rho_o \times \frac{0.101325 + P}{0.101325} \times \frac{293.15}{273.15 + t}$$ formula（4）

（c）Mass flow rate Q_m charge to volume flow Q_v

$$Qv = Q_m \times 10^3 / \rho$$ formula（5）

Among formula(5):

Q_v: volume flow of medium under working condition (m^3/h)

（Q_v=3600f/K K: coefficient of meter ）

Q_o:volume flow under standard condition(Nm^3/h)

Q_m:mass flow rate (t/h)

ρ:density of medium under working condition(kg/m^3)

$ρ_o$:density of medium under normal state(kg/m^3),common air medium density under normal state,as chart III

P:gauge pressure of working state (MPa)

t:Temp of working state(℃)

3.To ensure lower limit capacity.For the upper limit capacity of flow meter may be not counted under ordinary condition,so that just count its lower limit for choosing caliber. Shall meet two conditions:Minimum Reynolds number shall be not less than limited（Re=2×10^4）;for vortex street flow meter with stress type set, it take vortex intensity from lower limit capacity shall be more than limited sensor intensity(vortex intensity and lift force,as scaling relation as $ρv^2$).Relation as follow:

For density to test measurable lower limit flow:

$Q_\rho = Q_O \times \sqrt{\rho_O / \rho}$ formula (6)

For kinematic viscosity to test linear lower limit flow:

$Q_\upsilon = Q_O \times \upsilon / \upsilon_O$ formula（7）

Medium:

Q_ρ:Meet request of vortex intensity, the minimum volume flow (m^3/h)

ρ_0:medium density under reference condition

Q_U:Meet request of Min-Reynolds number, the minimum linear volume flow (m^3/h)

ρ:The density of tested medium under working condition（kg/m^3）

Q_0:minimum volume flow of meter under reference condition (m^3/h)

υ:kinematic viscosity of medium under working condition (m^2/s)

υ_o:kinematic viscosity of medium under reference condition (m^2/s)

by means of formula（6）&（7）to come out Q_ρ& Q_v.compare with Q_ρ& Q_v, to ensure measurable range of lower limit flow & linear lower limit flow:

$Q_U \geq Q_\rho$:measurable range= Q_ρ～Qmax,linear flow range= Q_U～Qmax

$Q_U < Q_\rho$:measurable range & linear flow range

Q_ρ～Qmax

Qmax:upper limit volume flow (m^3/h)

4.The standard of upper limit flow,See(II).gaseous upper limit flow velocity shall be less than 70m/s,liquid shall be less than 7m/s.

5.When tested gas is steam,often use quality flow as unit of measurement quality flow,as:t/h or Kg/h.because of steam(overheating & saturated),density would be changed under different temp & press,so to ensure the flow range,see (8)

$Q_S = 1.5 Q_{Air} \times \rho \times 10^3 \times \sqrt{\rho_o / \rho}$ formula（8）

TIPS:

ρ:density of vapor（kg/m^3）

ρ_0:1.205kg/m^3

Q_S:quality flow of vapor（t/h）

6.For pressure loss,check the effect of pressure loss to craft pipeline,(Unit:Pa):

$\Delta p = C_d \rho V^2/2$ formula（9）

Δp:pressure loss（Pa） Cd:coefficient of pressure loss

Tips：

P:density of medium under working condition（kg/m^3）V:mean flow rate（m/s）

7.If tested medium is liquid,to avoid gasification and loss,shall make the press of pipeline as follow:

$p \geq 2.7\Delta p + 1.3 p_0$ formula（10）

Tips:

Δp:pressure loss（Pa）

p_0:saturated vapor pressure of liquid which under working temperature.

（Pa absolute pressure）

Po:fluidic vapor pressure

(Pa absolute pressure)

8.vortex street flow meter is not suitable for testing high viscosity liquid.if counted measurable lower limit flow is not suitable for designing,pls select and use other meter type.

9.If as the counted parameter,the two or more kinds of meter can be used,then use less caliber,cheaper.

Tips: as far as possible tested range during upper limit of about 1/2～2/3.

Chart(II) Flow Range of Working condition under Reference Condition

DN(mm)	liquid		gas	
	Flow Range(m^3/h)	Frequency Output Range(Hz)	Flow Range (m^3/h)	Frequency Output Range(Hz)
25	1.2～16	25～336	8.8～55	190～1140
40	2～40	10～200	27～205	140～1040
50	3～60	8～160	35～380	94～1020
80	6.5～130	4.1～82	86～1100	55～690
100	15～220	4.7～69	133～1700	42～536
150	30～450	2.8～43	347～4000	33～380
200	45～800	2～31	560～8000	22～315
250	65～1250	1.5～25	890～11000	18～221
300	95～2000	1.2～24	1360～18000	16～213
(300)	100～1500	5.5～87	1560～15600	85～880
(400)	180～3000	5.6～87	2750～27000	85～880
(500)	300～4500	5.6～88	4300～43000	85～880
(600)	450～6500	5.7～89	6100～61000	85～880
(800)	750～10000	5.7～88	11000～110000	85～880
(1000)	1200～17000	5.8～88	17000～170000	85～880
>(1000)	Customized		Customized	

Notes：DN300～DN1000 is plug-in type.

Chart(III) Density of Normal Gas (0 deg.C,P=0.1MPa)

name	density (kg/m^3)	name	Density(kg/m^3)
air(dry)	1.2928	acetylene	1.1717
nitrogen	1.2506	ethylene	1.2604
oxygen	1.4289	propylene	1.9140
argon	1.7840	methane	0.7167
Ne	0.9000	ethane	1.3567
ammonia	0.7710	propane	2.0050
hydrogen	0.08988	butane	2.7030
carbon monoxide	1.97704	natural gas	0.8280
carbon dioxide	1.3401	Coal gas	0.8020

III.Model Selection:

Example I:When know the gas pressure,temp. and flow range under standard condition

The compressed air,flow range under standard condition is Q_N=1200-12000Nm^3/h,press P=0.7Mpa(Gauge Pressure),temp t=30℃.Steps of choosing the flowmeter diameter as following:

Step I：Calculate the volume flow of compressed air under working condition

According to formula(3):

The lower limit of volume flow under working condition:

$Q_{vmin}=Q_N\times0.101325\times(273.15+t)/293.15/（P+0.1）$

$=1200\times0.101325\times(273.15+30)/293.15/（0.7+0.1）$

$=157(m^3/h)$

upper limit flow under working condition: $Q_{vmax}=1570(m^3/h)$

StepII:flow range as working condition 157-1570m³/h,SEE TABLE (II),Meet lower limited flow DN80,DN100 and DN125,consider upper limit flow 1270m³/h and useful &cost,primary DN100,DN100 range:100-1700m³/h, approach flow range,primary DN100 flow meter,but shall count lower limit flow of DN100 flow meter under working condition,to count as follow:

as formula (4) and formula (6):

$$Q_\rho = Q_O \times \sqrt{\rho_O / \rho}$$

$$= 100 \times \sqrt{\frac{0.101325 \times (273.15 + 30)}{(0.101325 + 0.7) \times 293.15}}$$

$$= 37.46(m^3/h)$$

It means,measurable lower limit flow of flow meter which under this kind of condition:

37.46m³/h,less than lower limit flow nder working condition,so DN100 low meter is choosed.

Example II:When know the steam pressure,temp. and flow range under standard condition

Medium is superheated steam,steam temp 320℃,press:1.5MPa(absolute pressure),flow range:3t/h～25t/h,steps to make sure the diameter of meter.

Step I:To calculate volume flow of steam under the reference condition of equivalent air,See attach table (II),steam density is:5.665Kg/m³, and as formula (8) :

$$Q_{\text{Air}} = Q_S \times 10^3 / 1.5\sqrt{\rho_o \rho} \quad Q_{\text{Air min}} = 3000 / 1.5 \times \sqrt{5.665 \times 1.205}$$

$$= 765(m^3/h)$$

$$Q_{\text{Air max}} = 6379(m^3/h)$$

Step II:as this range 765-6379m³/h，see table（II）

the size of DN200 is suitable for it.

■ Type Selection

1.Model selection table of vortex street flow meter（JB/T9294-1999 standard）

Model chart									Describing
FV									vortex street meter
T									sensor
TEST WAY		B							piezoelectric transducer
		E							Capacitance sensor
Joint way		1	full package type						flanged joint type
		2	full package type						flanged installing type
		3	plug-in type						simple plug-in
		4	plug-in type						ball valve plug-in
Test medium			2						liquid
			3						gas
			4						vapor
inside nominal diameter				02 … 30					DN25 … DN300 Unit:mm
service environment	—				P				ordinary type
					B				explosion proof type
output signal						1			output pulse
						2			4 ～ 20mA current output,liquid-crystal display
						3			RS-485 communication
						4			battery supply feed,without Temp, get pressure
						5			Tem-pre system,4～20mA current output type
						6			Tem-pre system,battery supply feed type
model selection	E.g.:FVTE2405-P2 full package type capacitance vortex street meter, flanged installing type joint,medium is vapor drift diameter of meter is DN50,ordinary 4～20mA current signal output								

2. Table of comparisons sensor drift diameter

inside nominal diameter DN mm	25	32	40	50	65	80	100	125	150	200	250
Sign NO.	02	03	04	05	06	08	10	12	15	20	25
inside nominal diameter DN mm	300	350	400	450	500	600	700	800	1000	1200	1500
Sign NO.	30	35	40	45	50	60	70	80	A0	A2	A5