Piezoelectric / Capacitance

Vortex flow meter

Instruction manual

LUGB

Part I：MANUAL

Range & Series

a.(LUGB) Pipe-piezoelectric type vortex flow meter
b.(LUGB) Insert-piezoelectric type vortex flow meter
c.(LUGB) Pipe-capacitance type vortex flow meter
d.(LUGB) Insert -capacitance type vortex flow meter
e.(LUGB) battery supply feed type vortex flow meter
f. Dive type/part body vortex flow meter(order by agreement)
g. Curve-record integrating instrument, with P/T system and liquid crystal display(English)
h. Integrating instrument,with tube show.

(LUGB)series is suitable for oil,chemical industry,metallurgy,heating power,spinning, Paper making ,etc. Beuse of control: over-heating vapor, saturation vapor, compressed air, ordinary air(oxygen, nitrogen, hydrogen, natural gas, coal gas ,etc),water and liquid (water, petrol ,alcohol, benzene ,etc.)

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 flow ,Chart I as follow.

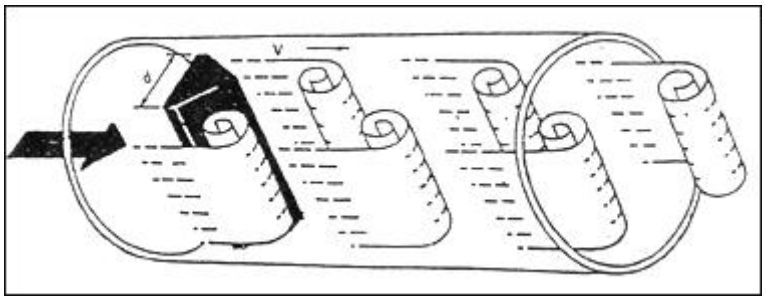


chart I

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 flow, as follow:

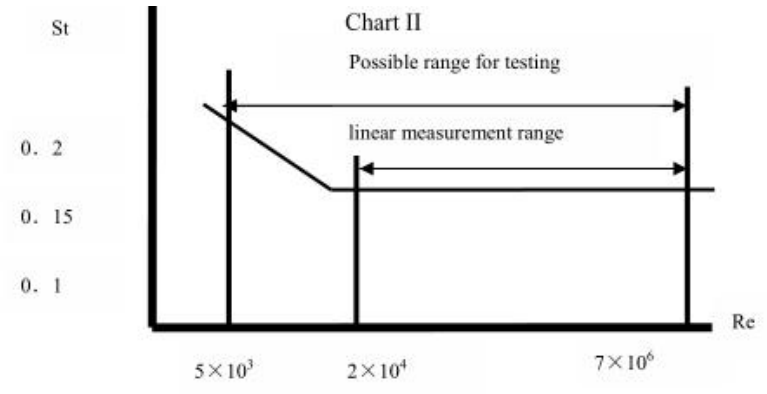
$f=StV/d$ I

Factor：

f—The Karman vortex flow frequency which one side of vortex-maker
St— Strouhal number (dimensionless number)
V—mean flow rate
d—the width of vortex-maker

So, check the separate frequency of Karman vortex 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 follow(2)

$K = N/Q(1/m^3)$ (2)

Model：K＝instrument constant($1/m^3$) .

N＝impulse number

Q＝volume flow(m^3)

The key technical indexes

nominal nominal diameter (mm)	10,15,20,25,40,50,65,80,100,125,150,200,250,300,(300～1000 plug-in)
nominal pressure (MPa)	DN10-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	Stainless Steel 316L, Stainless Steel 304
vibrating acceleration	piezoelectric type:0.2g capacitance:1.0～2.0g
range	±1%R,±1.5%R,±1FS；plug-in：±2.5%R,±2.5%FS
Range degree	1：6～1：30
service 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
loss coefficient	JB/T9249 Cd≤2.4
anti-explosion sign	Ben-an type：ExdIIia CT2-T5 anti-explosion type：ExdIICT2-T5
Protection grade	ordinary type IP65 dive type IP68
environment condition	Tem-20℃～55℃,relative humidity 5%～90%,atm press 86～106kPa
medium	gas、liquid、vapor
transmission range	three-wire system flow sensor：≤300m,electric sign of two-wire system transmitter (4～20mA)：load resistance≤750Ω

Part II : Model selecting & Installing for meter

It is important for selecting model, the key to use, so client must read this chapter carefully, and if find question, you can contact us.

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:reference condition as follow:

1．air：Normal Temp & press,t=20℃,P=0.1MPa (absolute pressure) ,ρ=1.205kg/m3 ,υ=15×10 -6 m 2 /s.

2．Liquid：normal temperature water,t=20℃,ρ=998.2kg/m3 ,υ=1.006×10 -6 m 2 /s.

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;

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

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

$$\rho = \rho_o \times \frac{0.1'01325 + P}{0.101325} \times \frac{293.15}{273.15 + t} \quad \text{formula (4)}$$

(c)Mass flow rate Q m　charge to volume flow Q v

$$Qv = Q_m \times 10^3 / \rho \quad \text{formula (5)}$$

Among formula(5)：

Q v ; volume flow of medium under working condition (m3 /h) (Q v =3600f/K K: coefficient of meter)

Q o volume flow under standard condition(Nm3 /h)

Q m :mass flow rate (t/h)

ρ :density of medium under working condition(kg/m3)

ρ o　density of medium under normal state(kg/m3) , common air medium density under normal state,as chart III

P：gage pressure under working state (MPa)

t：Temp under 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 Diameter. Shall meet two conditions ： Minimum Reynolds number shall be not less than limited(Re=2×104) ； for　vortex flow 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 ρv2). Relation as follow:

For density to test measurable lower limit flow：

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

For kinematic viscosity to test linear lower limit flow：

$$Q_\upsilon = Q_O \times \upsilon / \upsilon_O \qquad \text{formula (7)}$$

Medium:

Q ρ:Meet request of vortex intensity, the minimum volume flow (m3 /h)

ρ 0 :medium density under reference condition

Q υ :Meet request of Min-Reynolds number,the minimum linear volume flow (m3 /h)

ρ:The density of tested medium under working condition(kg/m3)

Q 0:minimum volume flow of meter under reference condition (m3 /h)

υ:kinematic viscosity of medium under Model selecting & Installing for meter working condition (m 2 /s)

υ o:kinematic viscosity of medium under reference condition (m2 /s)by means of formula(6)&(7)to come outQ ρ & Q ν . compare with Q ρ & Q ν , to ensure measurable range of lower limit flow & linear lower limit flow :

Q υ ≥Q ρ:measurable range= Q ρ ～Qmax ,linear flow range= Q υ ～Qmax

Q υ <Q ρ:measurable range & linear flow range

Q ρ ～Qmax

Qmax:upper limit volume flow (m3 /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 vapor,often use quality flow as unit of measurement quality flow,as:t/h or Kg/h. because of vapor (overheating & saturated),density would be changed under different temp & press,so to ensure the flow range, see (8)

$$Q_{蒸汽} = 1.5 Q_{空气} \times \rho \times 10^3 \times \sqrt{\rho_o / \rho} \quad \text{formula(8)}$$

TIPS:

ρ:density of vapor(kg/m 3)

ρ 0:1.205kg/m 3

Q Steam:quality flow of vapor(t/h)

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

Δp= CdρV2 /2 formula(9)

Tips：

P:density of medium under working condition(kg/m3)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≥2.7Δp+1.3p 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 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 Diameter, cheaper. Tips: as far as possible tested range during upper limit of about 1/2～2/3.

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

chart(II) extent table of reference condition under working condition

Diameter (mm)	liquid		gas	
	range(m 3 /h)	Output frequency range (Hz)	measurement range (m 3 /h)	Output frequency range (Hz)
10	-	-	0.2-2	-
15	0.3-6	88-580	2-40	240-2350
20	0.6-12	38-422	4-60	210-2132
25	1-16	25-336	8-100	190-2100
40	2-40	10-200	27-205	140-1040
50	3-60	8-160	35-380	94-1020
65	4-65	6-77	68-680	80.7-807
80	6.5-130	4-82	86-1100	55-690
100	15-220	4-69	133-1700	42-536
125	20-250	3.3-41.6	230-2500	38-416
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	agreement		agreement	

Tips:above table the Diameter (300)～(1000) is plug-in

table(III) the density of common gas under normal state(0℃, absolute pressure P=0.1MPa)

Name	Density(kg/m3)	Name	Density(kg/m3)
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:the flow which known air press & temp under standard condition.Some compressed air,flow range under standard condition is Q N =1200-12000Nm 3 /h,press P=0.7Mpa(pressure), temp t=30℃. To ensure Diameter of flow meter.

Step I： the working volume flow of compressed air by formula(3):

Minimum volume flow:

Q vmin =Q N ×0.101325×(273.15+t)/293.15/(P +0.1)

=1200×0.101325×(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 157-1570m 3 /h,SEE TABLE (II) ,Meet lower limited flow DN80,、DN100 and DN125, consider upper limit flow 1270m 3 /h and useful &cost , primary DN100, DN100

range :100-1700m 3 /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):

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

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

$$= 37.46(\mathrm{m}^3/\mathrm{h})$$

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

37.46m 3 /h , less than lower limit flow under working condition,so DN100 low meter ischoosed

Example II ： known temp and working condition flow super heated steam is tested medium,,vapor temp 320℃,press: 1.5MPa(absolute pressure),flow range :3t/h～25t/h, how to ensure Diameter of meter. Step I：To count volume flow range of steamy equivalent air under reference condition,See attach table (II), vapor density under this condition is:5.665Kg/m 3 , and as formula (8) :

$$Q_{空气} = Q_{蒸汽} \times 10^3 / 1.5\sqrt{\rho_o \rho}$$

$$Q_{空气\min} = 3000 / 1.5 \times \sqrt{5.665 \times 1.205}$$

$$= 765(\mathrm{m}^3/\mathrm{h})$$

$$Q_{空气\max} = 6379(\mathrm{m}^3/\mathrm{h})$$

Step II：as this range 765-6379m 3 /h,see table(II) the Diameter of DN200 is suitable for it.

Part II :Design & installation

It is important to install meter ,if not installed well, then would affect precision, use-life and damage.I environmental request for installing:

1.To avoid strong current, high frequency and powerful switch set, power supply of meter shall be avoided to near by these equipment.

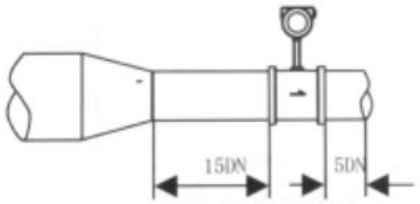
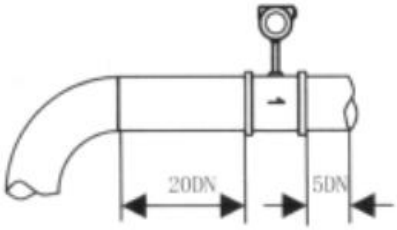
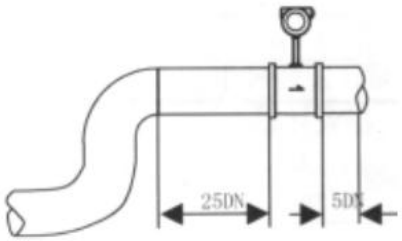
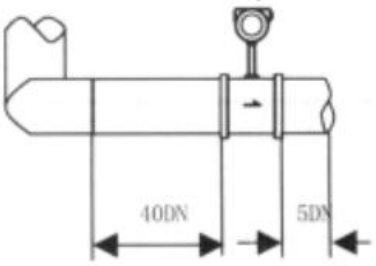
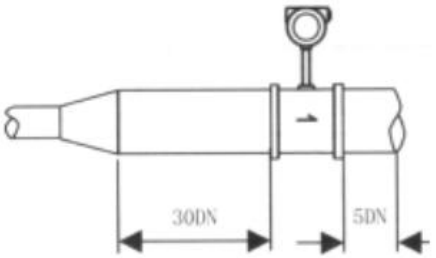
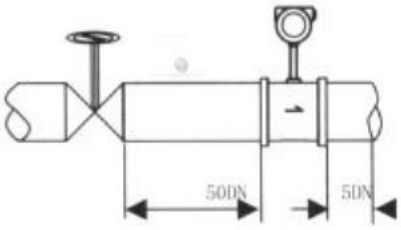
2.To avoid high-Temp & radiation source. if have to install it, need heat insulation & ventilated measure.

3.To avoid high-Temp & etchant gas, if have to install it, need ventilated measure.

4.vortex flow flow meter shall be avoided to install on shaking part of pipeline. if have to install on it,shall add clamp device and vibration pad which located on 2D to enhance shake proof . meter has better to installed indoors, pay attention to waterproof when installing meter outdoors,special notice the joint,make cable conductor to U shape to avoid water get into the amplifier body Around installing place shall save enough space,so that install connection line and maintenance routin**e.**

II Request for installing of pipeline meter：

5.vortex flow-flow meter need a request for about installing point up-down stream pipe,if not flow field of medium will be affected in pipeline, refer to measurement accuracy of meter. up-down stream pipe of meter as chart(III)D is nominal Diameter of meter

sensor upstream pipe type	front and back straight pipe length	sensor upstream pipe type	front and back straight pipe length
concentric contract opening-valve		90 degree elbow	
two 90 degree Elbow which on a same plane		two 90 degree Elbow which not on a same plane	
concentric expanded pipe		control valve half open the vale (not recommend)	

chart(III)

Tips: control valve shall not install on upstream of meter, it better to the downstream 10D.

6.Up-down internal diameter of pipe shall be same. if not,than internal diameter of pipe Dp and vortex flow meter inner diameter Db, shall be as follow

0.98Db≤Dp≤1.05Db

Up-down internal diameter of pipe shall be concentric with inner diameter of flow meter,The non- axiality shall be less than 0.05Db

7.sealing gasket which between meter with flange,can not joint inside pipe when installing,and its inner diameter shall more than meter `s about 1~2mm

8.Design for temp & press point. When test pipeline need install temp & pressure transmitter,pressure tap may be downstream of 3-5D, thermometer hole may be downstream of 6-8D,see chart(VII) .D is nominal Diameter,Unit：mm

9.Meter can be installed by horizontal, vertical and bias ways on pipeline.

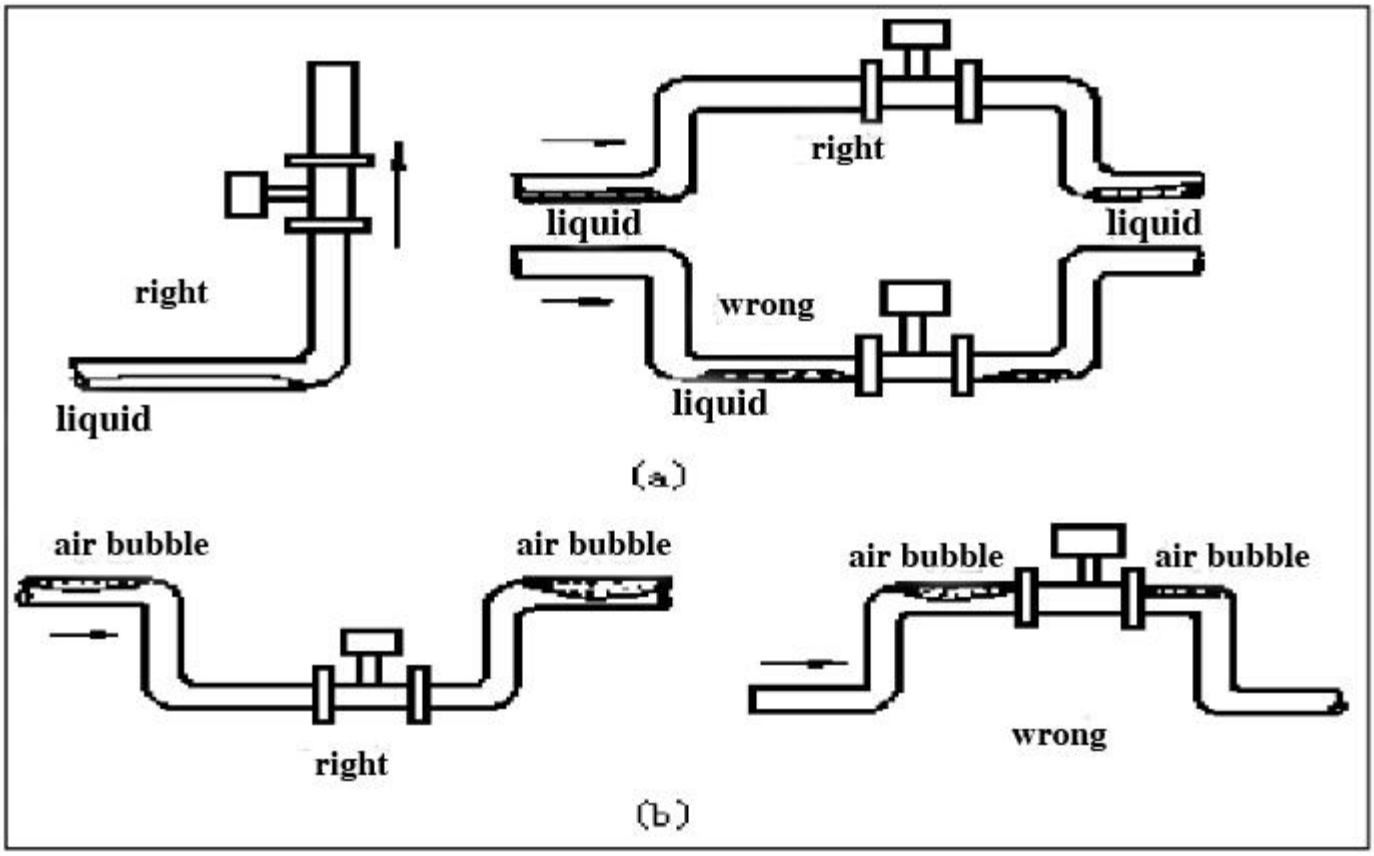
10.When test air, gas can flow anywhere when under uptake pipe to install. if there some air inside pipe ,to prevent liquid into the test pipe,so the air may from below to top, as list(IV)

11.When test for liquid,to ensure pipeline filled full,so install meter under vertical or bias working condition, shall ensure liquid flow from below to top. If there are some air inside of pipeline, meter may be installed under pipeline to prevent air into it.

As chart(IV)as follow:

Chart(IV) 正确=right , 液体=liquid, 错误=wrong,气泡= air bubble

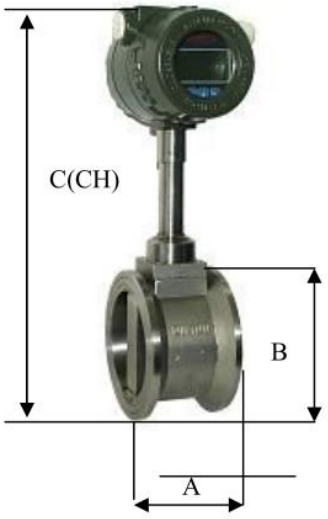
when test high& low temp medium,may pay attention to



heat preservation. inside changer(inside body of gauge outfit)must be not more than 70℃； if low temp inside will produce water into meter and reducing insulation.

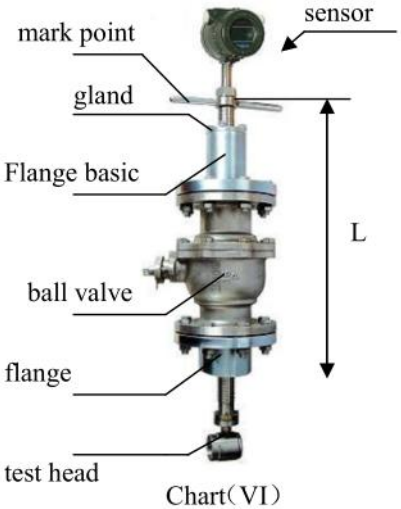
III Overall dimension installing of meter :SEE (V)& (VI)

Diameter(mm)	A	B	C	CH
10-25	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



ball valve & plug-in vortex flow meter for installing of location dimension

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



Chart（VI）

((IV)The steps of installing plug-in vortex flow meter:

1.Use gas welding to get a near φ100mm circular hole,and clear it so that make the measuring head would be work fine.

2.The flange which from manufacturer would be burned-on round hole of pipeline.

3.Take ball valve and sensor install on the flange.

4.Balance screw, so that insertion depth is pass muster(ensure central axis dead in line between test head with pipeline), fluid flow direction must be stay the same with arrows.

5.Balance gland screw.(Notice: lead screw swirl and seal degree is decided to gland screw elasticity)

6.Check every steps, opening valve slowly to ensure leakage (take care of body), if find leakage, do step 5,6 once more.

(V) Pt100 installing sketch map of PT100 and pressure transmitter

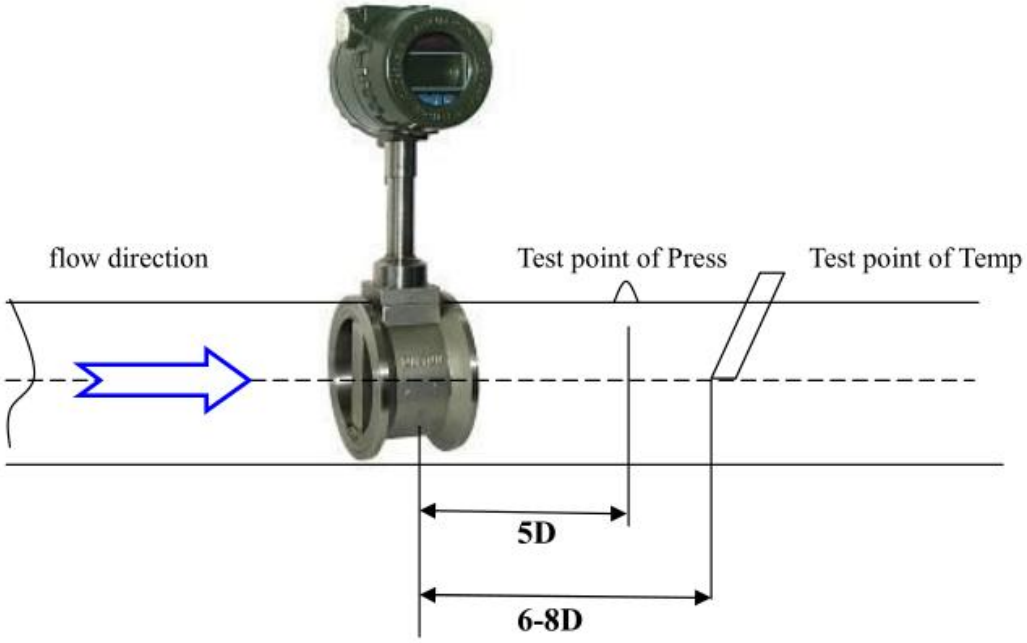
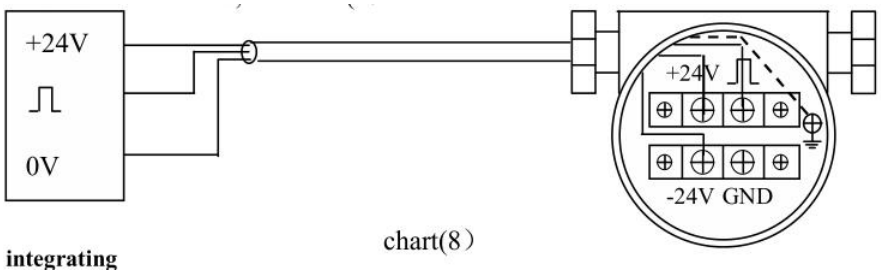


chart （VII）

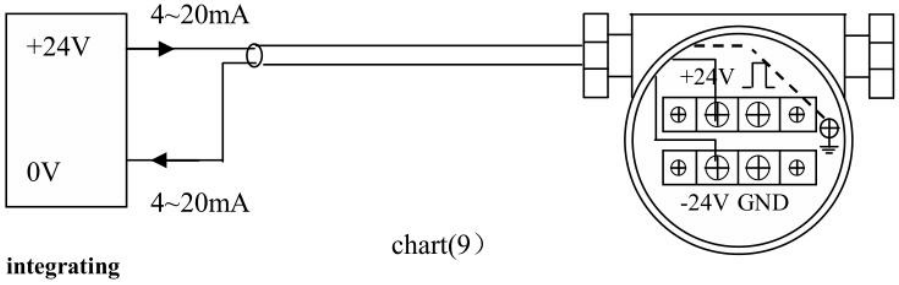
Part III: pipeline design

I. pipeline design for three-wire system vortex flow of output frequency signal meter
It use power supply of DC24V or DC12V, by means of three-core shield cable (RWP3×0.5mm)be joined with display devices or computer,shield shall be joined with ground connection screw of amplifier. The choice of shield cable shall be suitable for condition, besides shield cable shall be separated with, other high power line,not parallel line. Sensor connection end, see chart(8)



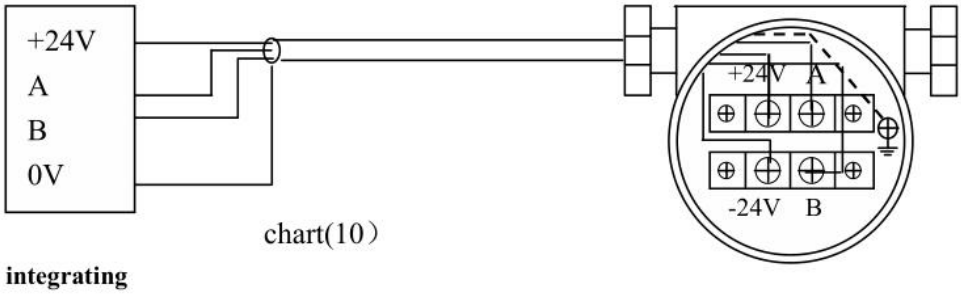
chart(8）

II．current signal two-wire system meter designing with Output standard(4~20mA)
It use DC24V power supply,by means of two-core shield cable (RWP3×0.5mm)be joined with display devices or computer, The choice of shield cable shall be suitable for condition, besides shield cable shall be separated with, other high power line,not parallel line. Sensor connection end, see chart(9)



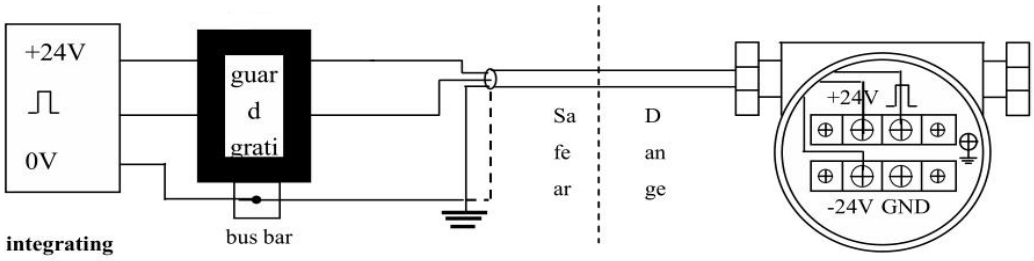
chart(9）

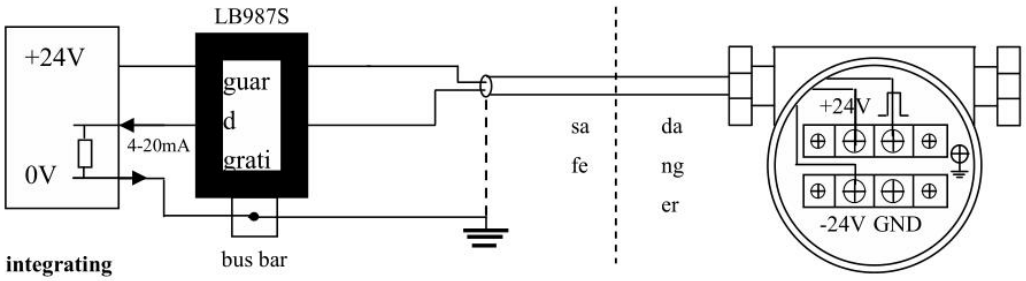
III． pipeline design of vortex flow meter with RS-485 communication interface function. communication interface
function.It use DC24Vpower supply,and use four-wire system way to transfer with other equipment, meter connection end, see(10)



chart(10）

IV ． pipe designing for antiriot type vortex flow meter
LUGB Vortex flow meter which with three-wire system pulse output shall be joined with LB987S Zener guard grating, LUGB Vortex flow meter which with two-wire system(4~20mA) current output shall be joined with LB987S Zener guard grating ,so could made a intrinsic safety system ,anti-explosion sign: Ex ia II CT2-T5. and these series for relevance equipment, would be as follow chart(11), chart(12).





chart（12）

Tips：

(1)explosion proof type sensor & transmitter would be installed on danger area,guard grating, indicating instrument, power supply and computer ,etc. shall be installed on safe area.

(2)sensor & transmitter shall use earth connection, anti-explosion ground wire shall be not used with strong current protective grounding together.