

SENCE INDUSTRIAL EQUIPMENT CO., LTD

Electromagnetic Flow meter



INSTRUCTION MANUAL

Vortex street meter

Model: CZ-UW

With LUG B and LUG E

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Electromagnetic Flow meter

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Part I : MANUAL

1. Range & Series

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

(LUGB/E) series is suitable for oil, chemical industry, metallurgy, heating power, spinning, papermaking ,etc. Be use 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 street.

Chart I as follow.

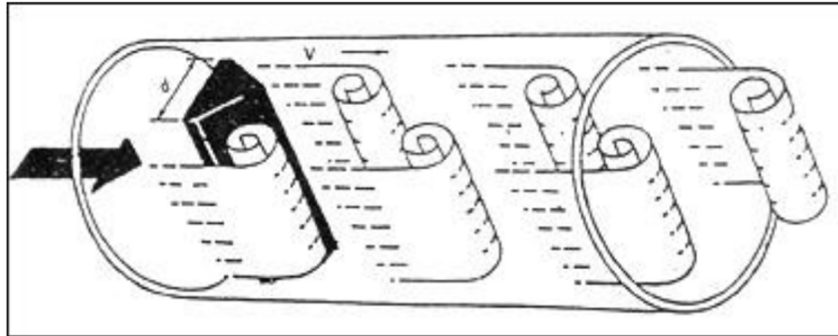


Chart I

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 street , as follow:

$$f=StV/d$$

Factor :

f —The Karman vortex street frequency which one side of vortex-maker

St —Strouhal number (dimensionless number)

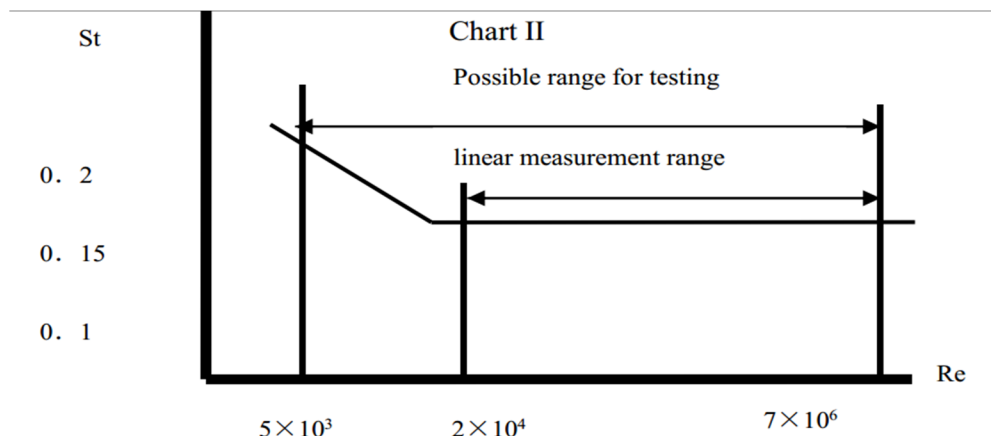
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V—mean flow rate

d—the width of vortex-maker

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 follow (2).

$$K=N/Q \text{ (1/m}^3\text{)} \text{ (2)}$$

Model : K=instrument constant (1/m³)

N=impulse number

Q=volume flow (m³)

The key technical indexes

inside 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)
noumenon	1Cr18Ni9Ti, (order by agreement if need other material)
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: ExdII ia CT2-T5 anti-explosion type: ExdII CT2-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: $\leq 300\text{m}$, electric sign of two-wire system transmitter (4~20mA) : load resistance $\leq 750\Omega$

Model selecting & Installing for meter

Part II :Model selecting & Installing formeter

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.

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, $t=20^\circ\text{C}$, $P=0.1\text{Mpa}$ (absolute pressure), $\rho=1.205\text{kg/m}^3$, $\nu=15\times 10^{-6}\text{m}^2/\text{s}$.
2. Liquid : normal temperature water, $t=20^\circ\text{C}$, $\rho=998.2\text{kg/m}^3$, $\nu=1.006\times 10^{-6}\text{m}^2/\text{s}$.

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;

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

Among formula(5) :

Q_v : Volume flow of medium under workingcondition (m³/h)

($Q_v = 3600 \text{ f/K}$ 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(°C)

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 ($Re=2\times 10^4$) ; 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 :

$$Q_p = Q_o \times \sqrt{\rho_o / \rho} \quad \text{Formula(6)}$$

For kinematic viscosity to test linear lower limit flow :

$$Q_v = Q_o \times \nu / \nu_o \quad \text{Formula(7)}$$

medium :

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

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(c) Mass flow rate Q_m change to volume flow Q_v $Q_v = Q_m \times 10^3 / \rho \quad \text{Formula(5)}$ 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) ν : kinematic viscosity of medium under working condition (m2/s) ν_0: kinematic viscosity of medium under reference condition (m2/s) by means of formula (6) & (7) to come out $Q\rho$ & $Q\nu$ Compare with $Q\rho$ & $Q\nu$, to ensure	ρ_0 : medium density under reference condition measurable range of lower limit flow & linear lower limit flow : $Q_0 \geq Q\rho$: measurable range= $Q\rho \sim Q_{\max}$, linear flow range = $Q\nu \sim Q_{\max}$ $Q_0 < Q\rho$: measurable range & linear flow range $Q\rho \sim Q_{\max}$ $Q_{\max}$: 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
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Design & installation for meter and ensuring caliber

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)

$$Q_{\text{蒸汽}} = 1.5Q_{\text{空气}} \times \rho \times 10^3 \times \sqrt{\rho_0 / \rho} \quad \text{Formula(8)}$$

TIPS :

ρ : density of vapor (kg/m3)

ρ_0 : 1.205kg/m3

$Q_{\text{蒸汽}}$:quality flow of vapor (t/h)

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

$$\Delta p = C_d \rho V^2 / 2 \quad \text{formula (9)}$$

Tips :

ρ : 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:

$$p \geq 2.7\Delta p + 1.3P_0 \quad \text{formula (10)}$$

Tips :

Δp : pressure loss (Pa)

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P_0 : saturated vapor pressure of liquid which under working temperature. (Pa absolute pressure)

P_o : 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 $1/2 \sim 2/3$.

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

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

caliber (mm)	liquid		gas	
	range(m ³ /h)	Output frequency range (Hz)	measurement range (m ³ /h)	Output frequency 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)	agreement		agreement	

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

Design & installation for meter and ensuring caliber

Table(III) the density of common gas under normal state (0°C, absolute pressure P=0.1MPa)

name	density (kg/m ³)	name	(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
<u>carbon dioxide</u>	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 QN=1200-12000Nm³/h, press P=0.7Mpa, temp t=30°C .
To ensure caliber of flow meter.

Step I : Calculate operating volume flow rate of compressed air By formula (3): The working condition uses the lower limit volume flow rate as:

$$\begin{aligned}Q_{vmin} &= QN \times 0.101325 \times (273.15 + t) / 293.15 / (P + 0.1) \\&= 1200 \times 0.101325 \times (273.15 + 30) / 293.15 / (0.7 + 0.1) \\&= 157(\text{m}^3/\text{h}) \text{ upper limit flow under working condition:}\end{aligned}$$

$$Q_{vmax} = 1570(\text{m}^3/\text{h})$$

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):

$$\begin{aligned}Q_p &= Q_o \times \sqrt{\rho_o / \rho} \\&= 100 \times \sqrt{\frac{0.101325 \times (273.15 + 30)}{(0.101325 + 0.7) \times 293.15}} \\&= 37.46(\text{m}^3/\text{h})\end{aligned}$$

It means, measurable lower limit flow of flow meter which under this kind of condition: 37.46m³/h, less than lower limit flow under working condition, so DN100 low meter is choosed

Example II : known temp and working condition flow

Superheated steam is tested medium,, vapor temp 320°C, press: 1.5MPa (absolute pressure), flow range :3t/h~5t/h, how to ensure caliber 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/m³ , and as formula (8) :

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

$$\begin{aligned} Q_{\text{空气 min}} &= 3000 / 1.5 \times \sqrt{5.665 \times 1.205} \\ &= 765(\text{m}^3/\text{h}) \end{aligned}$$

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

Step II : as this range 765-6379m³/h, see table (II) the caliber of DN200 is suitable for it.

Design & installation for meter and ensuring caliber

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 equipments.
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 street 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 routine

II. Request for installing of pipeline meter :

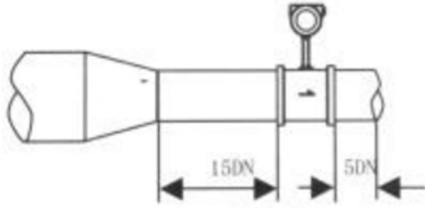
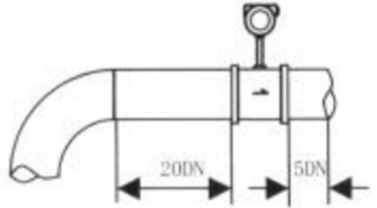
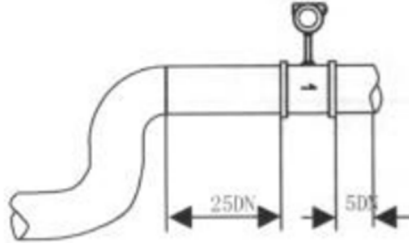
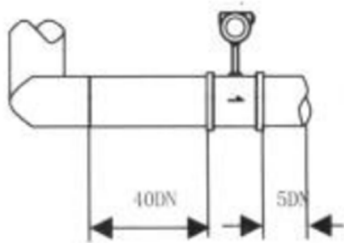
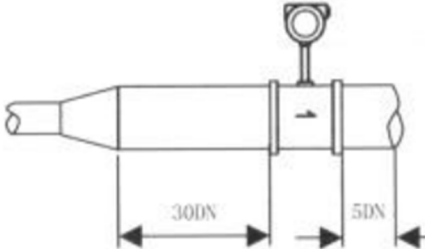
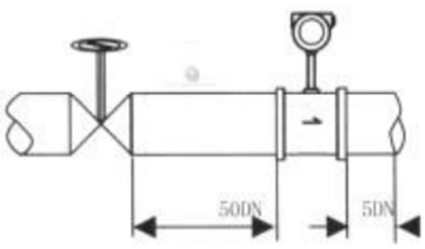
5. Vortex street-flow meter need a request for about installing point up-down stream pipe, if not flow field of medium will be affected in pipeline, refer to measurement accuracy of meter。 up-down stream pipe of meter as chart(III)

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D is nominal caliber of meter

UNIT: mm

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 D_p and vortex street meter inner diameter D_b , shall be as follow

$$0.98D_b \leq D_p \leq 1.05D_b$$

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

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 caliber, Unit : mm

Designing pipeline & caliber set

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) a

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:

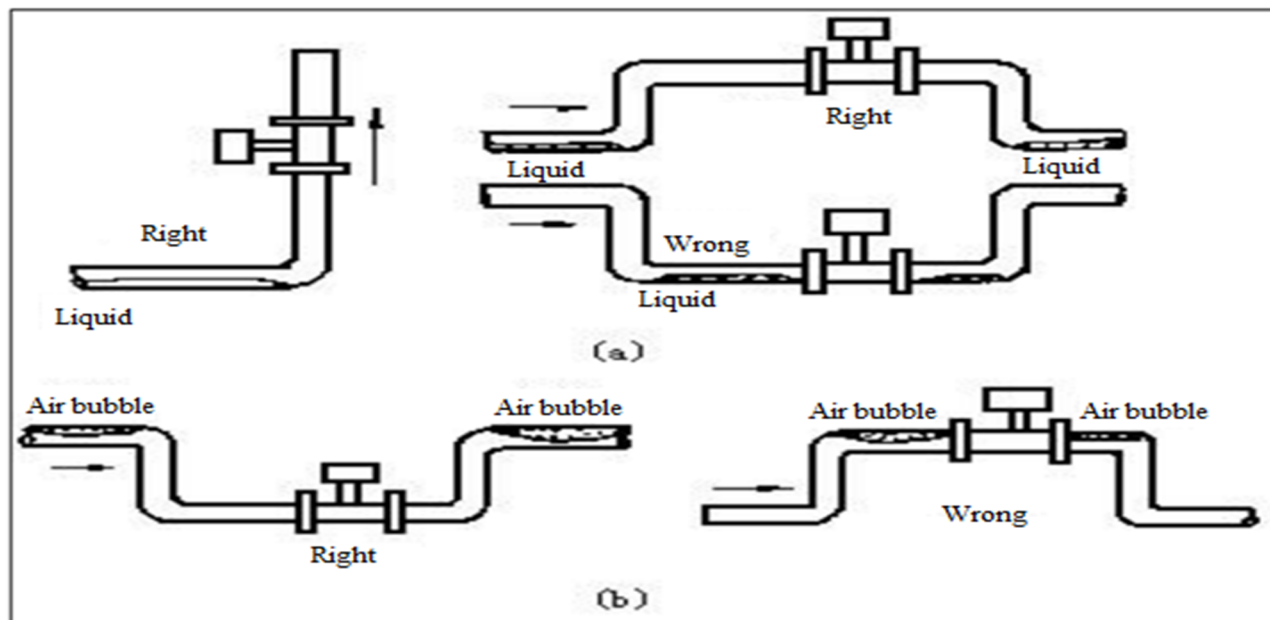
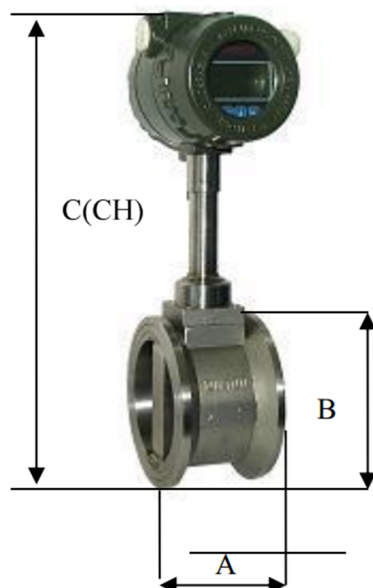


Chart (IV)

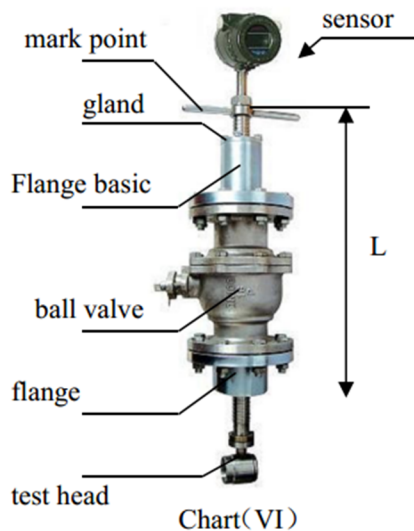
8. when test high& low temp medium, may pay attention to heat preservation. inside changer(inside body of gauge outfit) must be not more than 70°C ; if low temp inside will produce water into meter and reducing insulation.

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



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

Ensure meter for Installing , design & caliber



Chart(VI)

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

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

List (V)

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

1. Use gas welding to get a near $\phi 100\text{mm}$ 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

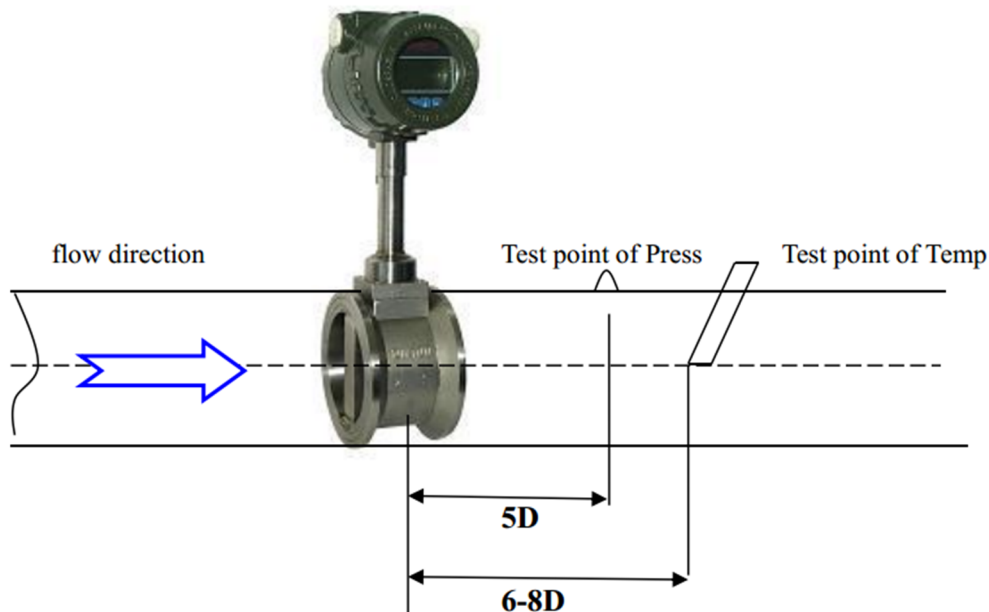


chart (VII)

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Appendix I A

Table of comparisons for saturation water-vapor density & platinum resistor-temp

indexing NO.: Pt100

R0=100.00 Ω

absolute pressure

Tem	Pre	Density	Platinum resistor	Tem	Pre	Density	Platinum resistor	Tem	Pre	Density	Platinum resistor
$^{\circ}\text{C}$	bar	kg/m^3	Ω	$^{\circ}\text{C}$	bar	kg/m^3	Ω	$^{\circ}\text{C}$	bar	kg/m^3	Ω
100	1.1033	0.5997	138.50	138	3.414	1.864	152.83	176	9.137	4.723	166.98
101	1.0500	0.6108	138.88	139	3.513	1.915	153.20	177	9.353	4.829	167.35
102	1.0878	0.6388	139.26	140	3.614	1.967	153.58	178	9.574	4.937	167.72
103	1.1267	0.6601	139.64	141	3.717	2.019	153.95	179	9.798	5.048	168.09
104	1.1668	0.6321	140.02	142	3.823	2.073	154.32	180	10.027	5.160	168.46
105	1.2080	0.7046	140.39	143	3.931	2.129	154.70	181	10.259	5.274	168.83
106	1.2504	0.7277	140.77	144	4.042	2.185	155.07	182	10.496	5.391	169.20
107	1.2941	0.7515	141.15	145	4.155	2.242	155.45	183	10.738	5.509	169.57
108	1.3390	0.7758	141.53	146	4.271	2.301	155.82	184	10.983	5.629	169.94
109	1.3852	0.8008	141.91	147	4.398	2.361	156.19	185	11.233	5.752	170.31

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110	1.4327	0.8265	142.29	148	4.510	2.422	156.57	186	11.488	5.877	170.68
111	1.4815	0.8528	142.66	149	4.634	2.484	156.94	187	11.747	6.003	171.05
112	1.5316	0.8798	143.04	150	4.760	2.584	157.31	188	12.010	6.132	171.42
113	1.5832	0.9075	143.42	151	4.889	2.613	157.69	189	12.278	6.264	171.79
114	1.6362	0.9359	143.80	152	5.021	2.679	158.06	190	12.551	6.397	172.16
115	1.6906	0.9650	144.17	153	5.155	2.747	158.43	191	12.829	6.533	172.53
116	1.7465	0.9948	144.55	154	5.293	2.816	158.81	192	13.111	6.671	172.90
117	1.8039	1.025	144.93	155	5.433	2.886	159.18	193	13.398	6.812	173.26
118	1.8628	1.057	145.31	156	5.577	2.958	159.55	194	13.690	6.955	173.63
119	1.9233	1.089	145.68	157	5.732	3.032	159.93	195	13.987	7.100	174.00
120	1.9854	1.122	146.06	158	5.872	3.106	160.30	196	14.298	7.248	174.37
121	2.0492	1.155	146.44	159	6.025	3.182	160.67	197	14.596	7.398	174.74
122	2.1145	1.190	146.81	160	6.181	3.260	161.04	198	14.909	7.551	175.10
123	2.1816	1.225	147.19	161	6.339	3.339	161.42	199	15.226	7.706	175.47
124	2.2504	1.261	147.57	162	6.502	3.420	161.79	200	15.549	7.864	175.84

SENCE INDUSTRIAL EQUIPMENT CO., LTD

Electromagnetic Flow meter

125	2.3210	1.298	147.94	163	6.667	3.502	162.16	201	15.877	8.025	176.21
126	2.3933	1.336	148.32	164	6.836	3.586	162.53	202	16.210	8.188	176.57
127	2.4675	1.375	148.70	165	7.008	3.671	162.90	203	16.549	8.354	176.94
128	2.5435	1.415	149.07	166	7.183	3.758	163.27	204	16.893	8.522	177.31
129	2.6215	1.455	149.45	167	7.362	3.847	163.65	205	17.243	8.694	177.68
130	2.7013	1.497	149.82	168	7.545	3.937	164.02	206	17.598	8.868	178.04
131	2.7831	1.539	150.20	169	7.731	4.029	164.39	207	17.959	9.045	178.41
132	2.8670	1.583	150.57	170	7.920	4.123	164.76	208	18.326	9.225	178.78
133	2.9528	1.627	150.95	171	8.114	4.218	165.13	209	18.699	9.408	179.14
134	3.0410	1.672	151.33	172	8.311	4.316	165.50	210	19.077	9.593	179.51
135	3.1310	1.719	151.70	173	8.511	4.415	165.87	211	19.462	9.782	179.88
136	3.2230	1.766	152.08	174	8.716	4.515	166.24	212	19.852	9.974	180.24
137	3.3170	1.815	152.45	175	8.924	4.618	166.61	213	20.249	10.17	180.61