

# **Cone differential pressure flow meter**

## **Operating manual**

**WIDE PLUS PRECISION INSTRUMENTS CO., LTD.**

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**Precise flow measurement**  
**An expert in the field of flow measurement**  
**Two-wire system connection**

**The following products may be replaced to use :**

|                             |         |                      |                   |
|-----------------------------|---------|----------------------|-------------------|
| Orifice plate               | Venture | Nozzle               | vortex flow meter |
| Vortex precession flowmeter |         | Rotameter flow meter |                   |

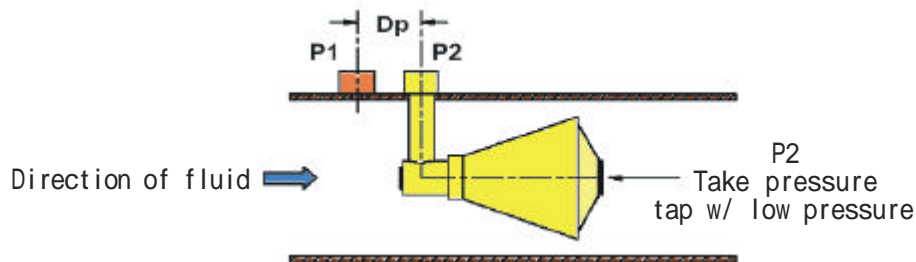
## 1. Introduction

Cone differential pressure flow meter that is an innovative flowmeter with high-precise flow measure and specially design to various kinds of difficult occasion carry out high-precisely survey to fluid.

The product is throttled down a V type cone that is hanged on the center of manifold. This will force the fluid is centered as the centerline of manifold, and washed around the cone. Compare with traditional throttling component, this kind of geometric figure has many advantages. This product doesn't bring visible influence to its accuracy of measurement because of its special design, and enable it to apply to difficult measuring occasion such as no straight length, flow disorder, and biphase compound bodies and so on.

## 2. Principle

Cone differential pressure flow meter belongs to differential pressure flowmeter that adopted the principle of conservation of energy. As shown in figure 1, when a medium is near measurement body, its pressure is P1, but when the medium pass over throttling zone of measurement body, its flow velocity is increased and its pressure is reduced to P2. Connecting P1 and P2 onto corresponding differential pressure transmitter via take pressure tap, and then work out the change of the flow according to changes of difference pressure. The fluid is proportional to square root of flow velocity of the medium in the pipeline. As shown in figure 1.



**Figure 1**

A V type cone is hanged in the center of pipeline. After the fluid washed the cone, its speed quickened and kinetic energy increased. Kinetic energy improved in the section is switched by a fall of rest energy below the cone that is, a low pressure zone will be formed by down stream of V type cone. The quantity of the fluid is in linear with square root of difference pressure produced around V type. That is Bernoulli theorem of mutual energy transformation in the sealed pipeline.

$$Q=KY$$

Where: Q= flow, K= constant, dimensionless, result from different flow

Y=expansion coefficient of gas, dimensionless, Y=1 when non-compression application

P=P1-P2, p= density of fluid

For cone-type differential pressure flowmeter:

K=

Where: K= instrument's coefficient, dimensionless, g= acceleration of gravity

$D$ =internal diameter of pipeline,  $d$ =external diameter of the cone,  $\beta$ =ratio of diameter, dimensionless,  $C$ =flow coefficient

### 3. Application

#### Application medium

Gas medium scale

Coal gas (coke oven gas, blast furnace gas, generating furnace gas, gas of city pipe), natural gas (include natural gas covering wet 5% below), air, Oxygen, Nitrogen, Hydrogen,  $CO_2$ ,  $CL_2$ , Methane gas, Propylene gas, fume, saturated steam, superheating steam, and wet gas and so on.

Liquid scale: water, oil (containing crude oil, gasoline, diesel oil, kerosene, residuum etc.) emulsion, pure water, hydrogen peroxide, glycerine, alcohol, sewage, benzene and the other various kinds of liquid.

#### Application area

- Oil, gas products and transportation
- petroleum refining
- purified water and waste water
- Chemical industry/medical technology
- energy/combined heat and power generation
- mining
- Paper pulp/papermaking
- manufacture
- food and beverage

#### Application condition

Form deep cooling to ultra critical situation

Temperature:  $-100 \sim 500$

Max. pressure: 40 MPa

Reynolds number scope:  $8 \times 10^3 \sim 5 \times 10^6$  (wide range)

Full differential pressure scope: form 0.1 ~ dozens of Kpa

### 4. Characteristics of flowmeter

- High accuracy: FS:  $\pm 0.5\%$
- High repeatability:  $\pm 0.2\%$  or more
- Reforming function about the field of flow velocity
- Requirement around straight length is lowest
- Ratio of wide-range: generally 1 ~ 10 (require even higher)
- Low loss of pressure
- Difficult application occasion: dirty liquid, wet gas, pulp
- Low ratio of noise
- Self-cleaning function

### 5. Specification

Accuracy:  $\pm 0.5\%$  F.S. (application of fixed fluid and Reynolds which may be required to specially check)

Repeatability:  $\pm 0.2\%$  or more

Ratio of range: 1 ~ 3 to 10 or higher

Standard  $\beta$  value: 0.45 ~ 0.85, special  $\beta$  value may be used

Loss of pressure: changes according to  $\beta$  value and differential pressure

Requirement of mounting pipeline: 0 ~ 3 times diameter before measuring body  
0 ~ 1 times diameter after measuring body

Material: carbon-steel, 304 or 316 L stainless steel, P/PTFE or using special material meet users requirements

## 6. Technical features

### Ratio of wide-range

Because of the design of cone differential pressure flowmeter is unique, its range is bigger, generally with from 1 : 3 to 1 : 30. If demand, it may be increased.. When Reynolds number is above 8000, its output signal is linear; if Reynolds number is below 8000, it needs to being modified to its output signal.

### Requirement of straight length is low

Due to the curve of the fluid is distributed uniformly, compare with other flowmeter, the requirements for upstream/downstream length is lower. Generally speaking, length both upstream 0 ~ 3D and downstream 0 ~ 1D will completely meet its requirement. When the product is applied to large pipeline or limited occasion of installation position, it has irreplaceable characteristics. As shown in figure 2.



Fig 2

### Long-term stability well

Special design in the cone which guaranteed the fluid is a gradation process and has no mutation when it flow the cone. First of all, the flow went through the cone, and then reached the edge of the cone again. So the cone couldn't be damaged frequently, value will always remain the same. If the apparatus will be used for a long time but needn't to be calibrated afresh.

When cone differential pressure flowmeter is to being calculated, its calculation formula adopted is the same with other differential pressure flowmeter, but the structure of throttling part is the different with other flowmeter that is realized by the cone in the center of manifolds hanged. This cone will force the medium in the center of pipeline is washed around the cone, as shown in figure 3, its distribution of flow velocity is very equal.

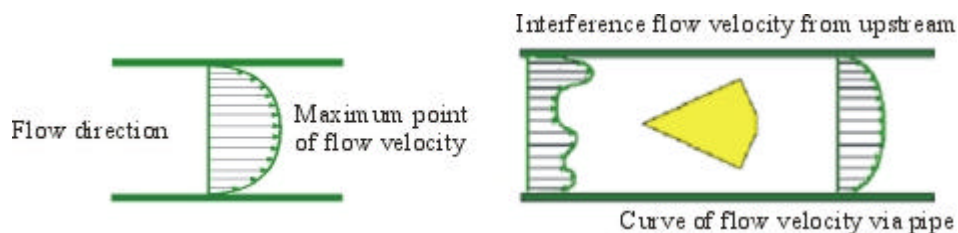


Figure 3

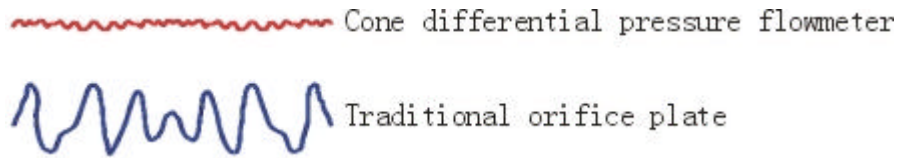
Due to the cone is hanged on the center of manifold, it directly contact with freeway zone in the fluid, to force the fluid at freeway zone is confused with the fluid near low speed zone of tube wall and then make flow velocity uniformity, therefore, flow velocity at freeway zone continued to decline. This is why cone differential pressure flowmeter is able to survey lower flow velocity.

Cone differential pressure flowmeter distributes the fluid uniformly under the worst circumstances, such as upstream the proximate instrument on which has single bend and double bend. The

distribution of the fluid is more uniform via rectified the cone so as to be sure to get higher accuracy of measurement under the worst circumstances. As shown in figure 3.

**Signal stability well**

All of flow meters that adopt difference pressure measure will have signal wave, this is because the fluid is very stable even if entering measuring instrument. After thought once measuring component, it will also bring signal wave, and then creating interference to reading of measuring instrument, as shown in figure 4, that is in contrast to signal wave produced by cone differential pressure flowmeter and orifice flowmeter.



**Figure 4**

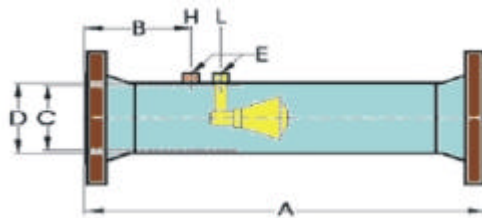
**With “self-cleaning function”**

The design of cone-type differential pressure flowmeter is unique, and made its cone doesn't exist dead zone, on the cone there don't accumulate fragments, viscosity or pollutant of the fluid, so with ability to “self-cleaning”

**7. Structural form**

Cone differential pressure flowmeter that is divided into three things: precise pipeline type: size DN15 ~ DN900 or bigger, mutual clip type: size DN15 ~ DN150, square type: size DN150 ~ DN900. this instruction takes pipeline type for example.

**8. Precise pipe dimension**



| Precise pipe dimension |        |        |                    |        |        |        |
|------------------------|--------|--------|--------------------|--------|--------|--------|
| Caliber                | Size A | Size B | Pipeline size      | Size D | Size E | Weight |
| Size                   | A      | B      | C (CS + Stainless) | D      | E      | Kg     |
| Caliber                | mm     | mm     | mm                 | mm     | G/NPT  |        |
| DN15                   | 200    | 90     | 15.8               | 21.3   | 1/4    | 4      |
| DN20                   | 200    | 90     | 20.9               | 26.7   | 1/4    | 5      |
| DN25                   | 200    | 90     | 26.64              | 33.4   | 1/4    | 6      |
| DN40                   | 250    | 80     | 41.78              | 48.3   | 1/4    | 7      |
| DN50                   | 300    | 85     | 53.44              | 60.3   | 1/2    | 9      |
| DN65                   | 300    | 85     | 63.60              | 73.0   | 1/2    | 11     |
| DN80                   | 350    | 90     | 78.84              | 88.9   | 1/2    | 16     |
| DN100                  | 400    | 90     | 103.8              | 114    | 1/2    | 23     |
| DN150                  | 550    | 100    | 154.1              | 168    | 1/2    | 50     |
| DN200                  | 650    | 120    | 202.7              | 219    | 1/2    | 118    |
| DN250                  | 700    | 120    | 254.5              | 273    | 1/2    | 153    |
| DN300                  | 750    | 130    | 303.4              | 323    | 1/2    | 186    |

|       |      |     |       |     |     |     |
|-------|------|-----|-------|-----|-----|-----|
| DN350 | 750  | 130 | 333.5 | 355 | 1/2 | 206 |
| DN400 | 750  | 140 | 381.0 | 406 | 1/2 | 262 |
| DN500 | 900  | 180 | 489.0 | 508 | 1   | 332 |
| DN600 | 1200 | 200 | 590.6 | 609 | 1   | 481 |
| DN700 | 1500 | 200 | 743   | 762 | 1   | 562 |
| DN800 | 1500 | 240 |       | 813 | 1   | 726 |
| DN900 | 1500 | 240 |       | 914 | 1   | 898 |

In the table, if there is any change, don't another notice.

## 8. Model and specification

Model and specification options for cone-type differential pressure flowmeter

| Model                             |    |    |   |    |   |   |  |  |  |      | Description  |
|-----------------------------------|----|----|---|----|---|---|--|--|--|------|--|
| <b>WP</b>                         |    |    |   |    |   |   |  |  |  |      |  |
| <b>Structural form</b>            | NT |    |   |    |   |   |  |  |  |      | Precision pipeline type  |
|                                   | PT |    |   |    |   |   |  |  |  |      | Precision square tube type                                       |
|                                   | GT |    |   |    |   |   |  |  |  |      | Ordinary clamp-hold type   |
| <b>Caliber</b>                    |    | () |   |    |   |   |  |  |  |      | DN15 mm ~ DN300 mm   |
|                                   |    | ST |   |    |   |   |  |  |  |      | Special size   |
| <b>Flange</b>                     |    |    | A |    |   |   |  |  |  |      | ANSI flanged standard  |
|                                   |    |    | D |    |   |   |  |  |  |      | DIN2501 flanged standard   |
|                                   |    |    | G |    |   |   |  |  |  |      | GB9115 national standard   |
|                                   |    |    | S |    |   |   |  |  |  |      | User's requirement   |
| <b>Degree of pressure</b>         |    |    |   | 10 |   |   |  |  |  |      | 1 MPa  |
|                                   |    |    |   | 16 |   |   |  |  |  |      | 1.6 MPa  |
|                                   |    |    |   | 25 |   |   |  |  |  |      | 2.5 MPa  |
|                                   |    |    |   | 40 |   |   |  |  |  |      | 4 MPa  |
| <b>Material of measuring tube</b> |    |    |   | 3  |   |   |  |  |  |      | 304 stainless steel  |
|                                   |    |    |   | L  |   |   |  |  |  |      | 316L stainless steel   |
|                                   |    |    |   | C  |   |   |  |  |  |      | Carbon-steel   |
|                                   |    |    |   | P  |   |   |  |  |  |      | PTFE/PP  |
|                                   |    |    |   | T  |   |   |  |  |  |      | Special material   |
| <b>Material of measuring cone</b> |    |    |   | 3  |   |   |  |  |  |      | 304 stainless steel  |
|                                   |    |    |   | L  |   |   |  |  |  |      | 316L stainless steel   |
|                                   |    |    |   | P  |   |   |  |  |  |      | PTFE/PP  |
| <b>Flange material</b>            |    |    |   | 3  |   |   |  |  |  |      | 304 stainless steel  |
|                                   |    |    |   | L  |   |   |  |  |  |      | 316 L stainless steel  |
|                                   |    |    |   | C  |   |   |  |  |  |      | Carbon-steel   |
|                                   |    |    |   | P  |   |   |  |  |  |      | PTFE/PP  |
| <b>Transmitter</b>                |    |    |   |    | 0 |   |  |  |  |      | None   |
|                                   |    |    |   |    | 1 |   |  |  |  |      | Standard   |
|                                   |    |    |   |    | 2 |   |  |  |  |      | Multi-parameter inspection with temperature, pressure, flow etc. |
|                                   |    |    |   |    | 3 |   |  |  |  |      | User's requirement   |
| <b>Secondary</b>                  |    |    |   |    |   | 0 |  |  |  | None |  |

|                    |   |  |  |
|--------------------|---|--|--|
| <b>apparatus</b>   | 1 |  | Standard display                                   |
|                    | 2 |  | With display, accumulation                         |
|                    | 3 |  | Display, accumulation and temperature compensation |
| <b>Accuracy</b>    | 2 |  | 0.2 degree   |
|                    | 5 |  | 0.5 degree   |
| <b>Protection</b>  | N |  | No protection                                      |
|                    | E |  | Protection   |
| <b>Accessories</b> | 0 |  | None   |
|                    | 1 |  | With manifolds                                     |
|                    | 2 |  | With matching flange                               |

### 1. Option for example: WP-NT0020G16L310N1

NT: precision pipeline type

0020: caliber DN20

G: GB9115 flange standard

16:1.6 MPa

L: material of measuring tube is 316L stainless steel

L: material of measuring component is 316 L stainless steel

3: connecting flange material is 304 stainless steel

1: standard transmitter

0: without secondary apparatus

N: no anti-explosion

1: with manifolds

### 2 . Please offer the following parameters when ordering

- (1) Caliber
- (2) Measuring medium
- (3) Maximum measuring range (or maximum flow  $M^3/H$ )
- (4) Normal working scope
- (5) Minimum measuring range (or minimum flow  $M^3/H$ )
- (6) Working pressure
- (7) Working temperature
- (8) Density of medium
- (9) Viscosity of medium
- (10) Using local average atmosphere

### 9. Attention for installation and service

Fluid direction of coned throttling device should be in conformity to arrow direction of equipment body

When measured medium is vapor or higher than 60 degree, which should be additionally mounting condenser to reduce temperature so as to avoid damaging inspection elements in the rear of differential pressure

Before mounting the equipment, please sweeping the pipeline in advance

Confirming the degree of pressure when ordered, be sure to usage in the range of pressure

Don't hit the cone in the pipeline, if there some cones tends to twist, then measuring accuracy will be affected.

After select to use the throttling device, random accompanied by a calculation book of range,



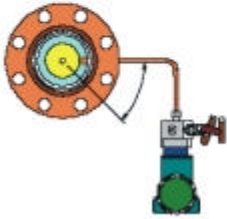
please check up on corresponding condition of process. If there is not the same, then contact us and afresh calculating range

Except damage by human factor, this equipment will be carried out quality assurance since the date of delivery within 18 months

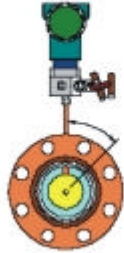
This equipment matches to use with differential pressure transmitter, its range refers to calculation sheet, and output signal must act as square root to deal with flow.

Attached reference diagram of installation

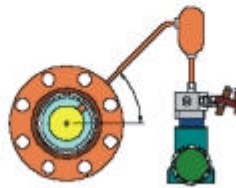
Liquid inspection mounting



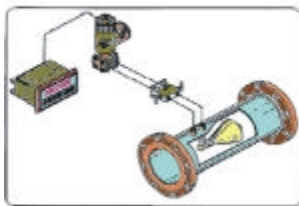
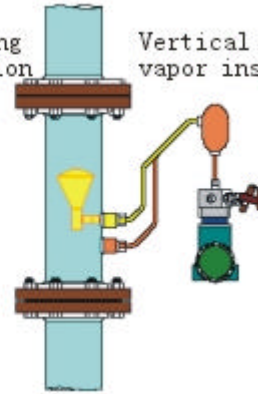
Gas inspection mounting



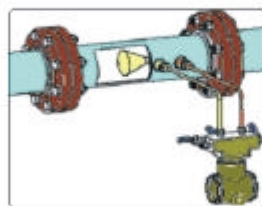
Horizontal mounting for vapor inspection



Vertical mounting for vapor inspection



Gas mounting



Liquid (vapor) mounting

Differential pressure

