# Selection Manual of PCL-M Thermal Gas Mass Flowmeter

## Features

- Direct measurement of mass flow rate without temperature and pressure compensation
- There are no flow-stopping or flow-blocking components in the measuring pipe, which will not cause pressure loss or blockage
- Simple structure, easy to install, no high requirement for straight pipe sections
- No mechanical transmission parts, strong and vibration-resistant
- Wide range ratio 100:1; Large bore, low flow rate, negligible pressure loss
- High-performance intelligent microprocessors and analog-to-digital, digital-to-analog conversion chips
- Suitable for flow measurement of all kinds of single or mixed gases

## Uses and Industries

- Oil and gas, chemical, metallurgy, pulp and paper, food and medicine, environmental protection and other industries

Measurement of biogas, gas, natural gas, liquefied gas, boiler preheating air

**Note:**

1 Do not misuse the document.

2 The information in this selection is for reference only and should not be used as a product installation guide.

3 Complete installation, operation and maintenance information is provided in the product manual

## Product Overview

The PCL-M series thermal gas mass flowmeter is designed based on the principle of thermal diffusion. This instrument uses the constant temperature difference method for accurate gas measurement. It has the advantages of small size, high degree of digitalization, easy installation and accurate measurement.

## Principle of Measurement

Thermal flowmeters are flowmeters designed based on the principle of thermal diffusion. That is, when a fluid flows over a heat-generating object, the amount of heat dissipated by the heat-generating object is proportional to the flow rate of the fluid. The thermal flowmeter has two standard platinum resistance temperature sensors, one used as the heat source and the other for measuring the temperature of the fluid. When the fluid flows, the temperature difference between the two is linearly related to the flow rate. Then, through microelectronic control technology, this relationship is converted into a linear output signal for measuring the flow rate. The gas mass flow rate is:$q_m$

$$q_m = \left[\frac{1}{C}\left(\frac{I_H^2 R_H}{T_0 - T_1} - \frac{B}{C}\right)\right]^2$$

The physical quantities represented by each parameter in the formula are respectively:

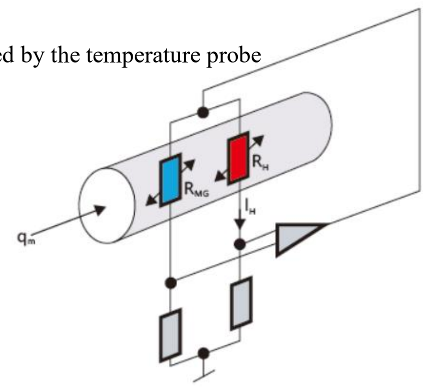
$I_H$: The current flowing through the heating resistor in the heating probe

$R_H$: Heating resistor resistance value

$T_0$: The temperature obtained by inverting the voltage and current across the heating resistor

$T_1$: The temperature of the gas measured by the temperature probe

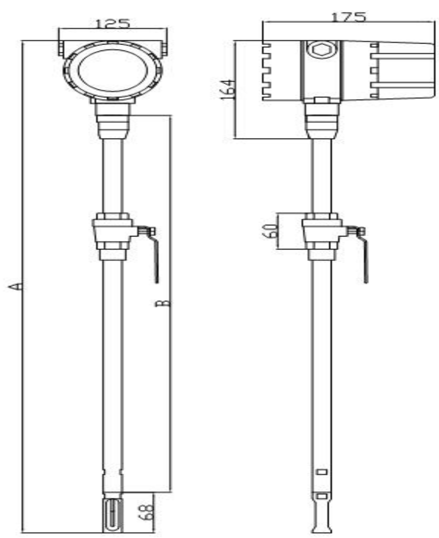
$B$And: Empirical coefficient$C$



## Performance parameters

| Structural form | Insertable | Pipe type |
|---|---|---|
| Measuring medium | Common steady-state gases (unstable media such as acetylene, boron trichloride cannot be measured) | |
| Pipe diameter range | DN50 to 4000mm | DN6 to 2000mm |
| Flow velocity range | 0.1 to 120Nm/s | |
| Accuracy | ±(1.5% reading + 0.3% full scale) | |
| Operating temperature | Sensor: -40 to +450 ° C Converter: -20 to +70 ° C | |
| Working pressure | Medium pressure ≤2.5MPa | Medium pressure ≤1.6MPa |
| Power supply | (DC 24V or AC 220V)≤18W | |
| Response speed | 1s | |
| Output signal | 4-20mA(optically isolated, maximum load 500 ohms), RS-485(optically isolated, custom required) | |
| Alarm | 1-2 normally open contacts, 24V/0.5A | |
| Supply type | Integrated structure | |
| Pipe material | Carbon steel, stainless steel, plastic, etc | |
| Live display | Four lines of Chinese character LCD display | |
| Display content | Mass flow, standard volume flow, cumulative flow, standard flow velocity, etc | |
| Protection level | IP65 | |
| Sensor material | Stainless steel | Stainless steel, carbon steel |

## External dimensions

| **Structural form** | **Dimension drawing Unit: mm** |
|---|---|
| **PCL-M series insertable thermal mass flowmeters** |  |



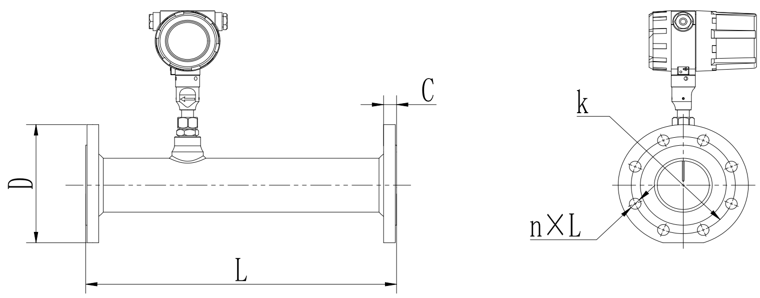
The external dimensions of the PCL-M series insertable thermal mass flowmeters are shown in Table 1 below.

Table 1 Dimensions table of insertable thermal mass flowmeters

| Nominal diameter | A | B |
|---|---|---|
| DN65-DN350(inclusive) | 560 | 340 |
| DN350-DN500(inclusive) | 640 | 425 |
| DN500 -DN1000(inclusive) | 820 | 600 |

Note: The PCL-M series insertable thermal mass flowmeter should be inserted into the axis of the pipe being measured, so the length of the measuring rod depends on the diameter of the pipe being measured. Please specify when placing the order. If it cannot be inserted into the pipe axis, the manufacturer will provide calibration coefficients for accurate measurement.

## Dimensions

| Structural form | Dimension drawing Unit: mm |
|---|---|
| **PCL-M series pipe section type thermal mass flowmeter** |  |

The external dimensions of the PCL-M series pipe section thermal mass flowmeter are shown in Table 2 below.

Table 2 External dimensions of pipe section thermal mass flowmeter

GB/T9119-2000 PN1.6Mpa(16bar) flat, raised plate flat welded steel pipe flange

| Nominal diameter | Flange outer diameter | Center hole diameter | Screw holes | Thread specifications | Sealing surface | | Flange thickness | Instrument mounting length |
|---|---|---|---|---|---|---|---|---|
| DN | D | K | N×L | | d | f | C | L |
| 15 | 95 | 65 | 4 x 14 | M12 | 45 | 2 | 12 | 170 |
| 20 | 105 | 75 | 4 x 14 | M12 | 55 | 2 | 14 | 170 |
| 25 | 115 | 85 | 4 x 14 | M12 | 65 | 2 | 14 | 170 |
| 32 | 140 | 100 | 4 x 18 | M16 | 78 | 2 | 16 | 170 |
| 40 | 150 | 110 | 4 x 18 | M16 | 85 | 3 | 18 | 170 |
| 50 | 165 | 125 | 4 x 18 | M16 | 100 | 3 | 18 | 170 |
| 65 | 185 | 145 | 4 x 18 | M16 | 120 | 3 | 20 | 190 |
| 80 | 200 | 160 | 8 x 18 | M16 | 135 | 3 | 20 | 190 |
| 100 | 220 | 180 | 8 x 18 | M16 | 155 | 3 | 22 | 200 |

Notes:

1. The flanges are in accordance with the national standard GB/T9119-2000. And manufactured in accordance with GB/T9119-2000 standard.

2. Pipe thread connection may be used for DN15 to DN80, but it can only be carried out after reaching a technical agreement with the instrument provider.

3. Only the maximum rated pressure data of 1.6Mpa is provided in the table. For pressures higher than the rated pressure, customization is possible, but it must be carried out after reaching a technical consensus with the instrument provider.

4. Installation dimensions of pipe sections with diameters above DN100 can only be produced after reaching an agreement with the instrument supplier.

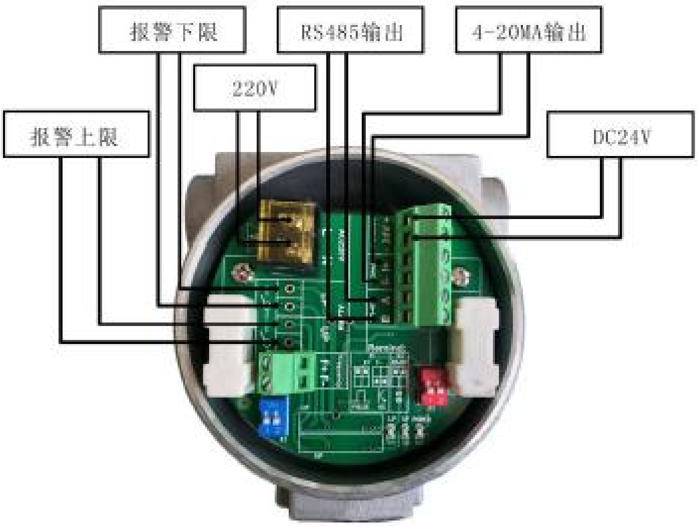
## Electrical connections

1. Instructions for sensor terminal blocks

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| RT1 | RT2 | RH1 | RH2 |

Temperature measurement (Pt1000) Speed measurement (Pt20)

2. Terminal block instructions and wiring method




When wiring, select the corresponding power terminal according to the product specification and connect to the power line, then connect to the signal line according to the required output signal.

Notes:

1. Do not operate with power on.

2 Con n the type of power supply.

## Installation

1. Installation notes

(1) If the instrument is installed outdoors, a sunshade should be added to protect it from sun exposure and rain.

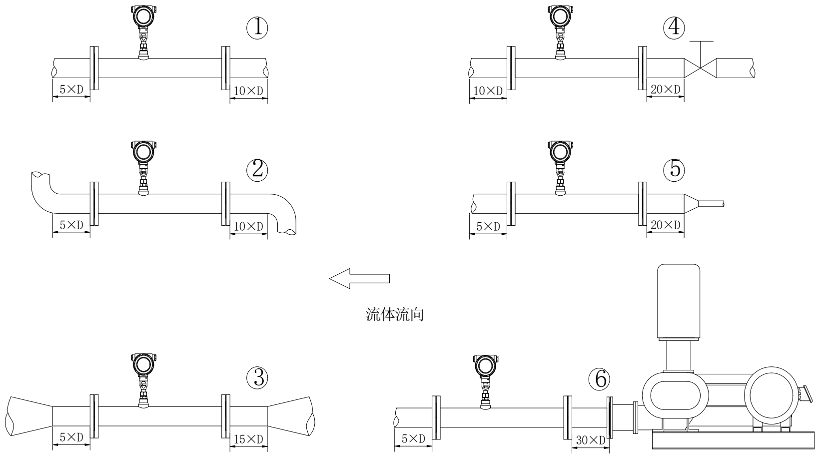
(2) Do not install in a place with strong vibration.

(3) Do not expose to environments containing large amounts of corrosive gases.

(4) Do not share power with equipment that contaminates the power source, such as frequency converters, welding machines, etc. If necessary, install a purification power supply for the converter.

2. Installation location and requirements for pipelines

When installing the instrument, keep away from elbows, obstacles, reducers and valves to ensure a stable flow field. One side requires a longer upper limit straight pipe, with the front straight pipe length greater than 10D(D is the inner diameter of the pipe) and the rear straight pipe section longer than 5D. The following figure shows the length of the straight pipe section required for several situations that are frequently encountered on site:




Installation requirements for front and rear straight pipe sections

The corresponding requirements for the front and back straight pipe sections are shown in Table 3.

| Pipe installation type | Serial Number | Front straight pipe section | Rear straight pipe section |
|---|---|---|---|
| Horizontal pipe | 1 | 10D | 5D |
| Bent tube | 2 | 10D | 5D |
| Expander tube | 3 | 15D | 5D |
| Valve downstream | 4 | 20D | 5D |
| Shrink tube | 5 | 20D | 5D |
| Pump downstream | 6 | 30D | 5D |

Note: When the straight pipe section requirement cannot be met on site, gas rectifiers can be connected in series to significantly reduce the requirement for the straight pipe section.

3. Thermal gas mass flowmeter base

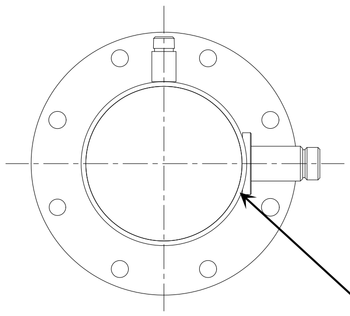
Figure 1 Online installation type welded base Figure 2 Simplified type welded

Notes:

1. Welding operations are prohibited in explosive environments.

2. Welding operations should be carried out in an environment with special requirements for welding.

The base is classified into standard type and simplified type based on different installation methods. During installation, the base should be placed at the very top of the pipe cross-section direction, and the axis of the base's through hole should be perpendicular to the pipe's axis. Ideal welding position and welding process for the base. (As shown below)



The base is to be processed into an arc of the same diameter as the pipe by wire cutting before

Figure 3 Ideal base welding position

## Selection code

PCL-M10-DA F3 P4 TA M1 G0 S1 D15 EX0

| Code | Explosion-proof |
|---|---|
| EX0 | No explosion-proof |

| Code | Medium |
|---|---|
| | The codes and media are shown in Table 6 |

| Code | Output signal | Code | Output signal |
|---|---|---|---|
| S1 | 4-20mA, RS485, pulse, frequency | S3 | 4-20mA, RS485, pulse, frequency +HART |
| S2 | 4-20mA, RS232, pulse, frequency | | |

| Code | Power supply | Code | Power supply |
|---|---|---|---|
| G0 | 24V DC | G1 | 220V AC |

| Code | Sensor material | Code | Sensor material |
|---|---|---|---|
| M1 | 304 stainless steel | M3 | Hastelloy C(HC) |
| M2 | 316L stainless steel | M4 | Ceramics (suitable for high-temperature gases) |

| Code | Medium temperature | Code | Medium temperature |
|---|---|---|---|
| TA | - 40 ~ 200 ℃ | TB | - 40 ~ 300 ℃ |

| Code | Rated pressure | Code | Rated pressure | Code | Rated pressure |
|---|---|---|---|---|---|
| P1 | PN10 | P4 | PN40 | PX | Other pressure levels |
| P2 | PN16 | P5 | PN60 | | |
| P3 | PN25 | P6 | PN100 | | |

| Code | Flange pipe type flange connection specification | Code | Insertable product flange connection specifications |
|---|---|---|---|
| | The codes and flange specifications are shown in Table 4 | | Code and flange specifications are shown in Table 5 |

| Code | Show type | Code | Show type |
|---|---|---|---|
| DA | One-piece | DB | Split type |

| Code | Process installation method | Code | Process Installation Method |
|---|---|---|---|
| PCL-M10 | Flanged pipe type thermal gas mass flowmeter | PCL-M20 | Insert-threaded connection thermal gas mass flowmeter |

Selection example: PCL-M10-DAF3P4TAM1G0S1D15EX0

Model description:

PCL-M10 flanged pipeline type thermal gas mass flowmeter, display type, flange connection specification DN50, rated pressure PN40, medium temperature -40~200 ° C, sensor material 304 stainless steel, power supply

24VDC, output 4-20mA, RS485, pulse, frequency The medium is propane ($C_3H_8$), with no explosion-proof requirements.

Table 4 Flange connection specifications (applicable pipe type, insert type see Table 5)

| Code | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Specifications | DN25 | DN40 | DN50 | DN65 | DN80 | DN100 | DN125 | DN150 | DN200 | Others |

Table 5 Flange connection specifications (applicable insert type, pipe type see Table 4)

| Code | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 |
|---|---|---|---|---|---|---|---|---|---|
| Specification | DN200 | DN250 | DN300 | DN350 | DN400 | DN450 | DN500 | DN600 | DN700 |
| Code | F10 | F11 | F12 | F13 | F14 | F15 | F16 | F17 | F18 |
| Specifications | DN800 | DN900 | DN1000 | DN1400 | DN1600 | DN1800 | DN2000 | DN3000 | Others |

## Selection Tips

According to the world's leading institutions, two-thirds of the faults of instruments in practical application are caused by incorrect selection and incorrect installation of the instruments. Therefore, the selection of flowmeters is a very important task in practical application. When making the selection, please note:

1 Collect process data

a. The name of the fluid being tested, as well as the composition of the chemical substances it contains;

b. The maximum flow rate, minimum flow rate and common flow rate of the fluid;

c. The maximum working pressure of the fluid;

d. The highest and lowest temperatures of the fluid.

2. The maximum and minimum flow rates must conform to the values in the flow range table.

3. The actual maximum working pressure must be less than the rated working pressure of the flowmeter's guide tube.

4. The maximum and minimum working temperatures of the fluid must meet the temperature requirements specified by the flowmeter.

5 Determine whether there is negative pressure in the process line.

6. You can choose the appropriate flowmeter based on the actual situation. If the inner diameter of the selected flowmeter does not match the inner diameter of the on-site process pipeline, the pipe should be reduced or expanded.

If the pipeline is reduced, it should be considered whether the pressure loss caused by the reduction will affect the process flow.

b. For the sake of improving measurement accuracy and product price, smaller diameter flowmeters can be selected to reduce economic input.

## Appendix:

1. Table of densities of general gases and conversion coefficients relative to air

At present, the laboratory cannot calibrate the mass flow rate according to the gas actually used by the user. Usually, the calibration is carried out after converting the flow rate of the gas actually used by the user into the flow rate of air. When users use it, what is directly displayed is the actual mass flow or volume flow of the gas used.

The conversion of different gases is done by conversion factor, and the conversion factor of a single component gas can be found in a table. Here is the table below:

Table 6 Density of gases and conversion coefficient of air

| Code | Gas | Specific heat (CAL/g ℃) | Density (g/l 0 ° C) | Conversion coefficient |
|---|---|---|---|---|
| D00 | Air | 0.24 | 1.2048 | 1.0000 |
| D01 | Argon Ar | 0.125 | 1.6605 | 1.4066 |
| D02 | Arsine AsH | 0.1168 | 3.478 | 0.6690 |
| D03 | Boron tribromide BBr | 0.0647 | 11.18 | 0.3758 |
| D04 | Boron trichloride BCl | 0.1217 | 5.227 | 0.4274 |
| D05 | Boron trifluoride BF | 0.1779 | 3.025 | 0.4384 |
| D06 | Borane $BH_2$ | 0.502 | 1.235 | 0.5050 |
| D07 | Carbon tetrachloride CCl | 0.1297 | 6.86 | 0.3052 |
| D08 | Carbon tetrafluoride CF | 0.1659 | 3.9636 | 0.4255 |
| D09 | Methane CH | 0.5318 | 0.715 | 0.7147 |
| D10 | Acetylene $C_2H$ | 0.4049 | 1.162 | 0.5775 |
| D11 | Ethylene $CH_2$ | 0.3658 | 1.251 | 0.5944 |
| D12 | Ethane $C_2H$ | 0.4241 | 1.342 | 0.4781 |
| D13 | Propyne $C_3H$ | 0.3633 | 1.787 | 0.4185 |
| D14 | Propylene $C_3H$ | 0.3659 | 1.877 | 0.3956 |
| D15 | Propane $CH_3$ | 0.399 | 1.967 | 0.3459 |
| D16 | Butyn $C_4H$ | 0.3515 | 2.413 | 0.3201 |
| D17 | Butene $C_4H$ | 0.3723 | 2.503 | 0.2923 |
| D18 | Butane $C_4H$ | 0.413 | 2.593 | 0.2535 |
| D19 | Pentane $C_5H$ | 0.3916 | 3.219 | 0.2157 |

Table 6(continued) Table of Gas Densities and Conversion Coefficients of air

| Code | Gas | Specific heat (CAL/g ℃) | Density (g/l 0 ° C) | Conversion coefficient |
|---|---|---|---|---|
| D20 | Methanol $CH_3OH$ | 0.3277 | 1.43 | 0.5805 |
| D21 | Ethanol $C_2H_6O$ | 0.3398 | 2.055 | 0.3897 |
| D22 | Trichloroethane $C_3H_3Cl$ | 0.1654 | 5.95 | 0.2763 |
| D23 | Carbon monoxide CO | 0.2488 | 1.25 | 0.9940 |
| D24 | Carbon dioxide CO | 0.2017 | 1.964 | 0.7326 |
| D25 | Cyanide $C_2N$ | 0.2608 | 2.322 | 0.4493 |
| D26 | Chlorine Cl | 0.1145 | 3.163. | 0.8529 |
| D27 | Deuterium D | 1.7325 | 0.1798 | 0.9921 |
| D28 | Fluorine gas F | 0.197 | 1.695 | 0.9255 |
| D29 | Germanium tetrachloride GeCl | 0.1072 | 9.565 | 0.2654 |
| D30 | Germane $GeH_4$ | 0.1405 | 3.418 | 0.5656 |
| D31 | Hydrogen H | 3.4224 | 0.0899 | 1.0040 |
| D32 | Hydrogen bromide HBr | 0.0861 | 3.61 | 0.9940 |

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