Straight Tube
Coriolis Mass Flow Meter

Operating Manual

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1 Straight Tube Mass Flow Meter Overview

Straight Tube Coriolis mass flow meter (MTCMF) is a new type flow meter which is designed according to Micro Motion and Coriolis principle.This kind of new flow meter can measure the fluid directly in a sealed pipeline. It consists of two sections: Sensor and Signal Transmitter.

1.1 Main Features

- It can directly measure the mass flow of the fluid (which is of great significance to the measurement and control of the production process, such as energy measurement and chemical reaction)
- High Accuracy（accuracy can be guaranteed in 0.1% ~ 0.5%)
- Wide measure range, generally ensure the basic accuracy of the measurable ratio of 10:1 or 20:1
- Wide range of applications, in addition to the normal fluid measurement can also measure the general fluid measuring instrument is difficult to measure the industrial medium, such as high viscosity fluid, all kinds of slurry, suspension, etc
- Measure the density and temperature of medium directly, and convert the concentration of the solute
- There is no requirement for the upstream and downstream straight pipe section of the instrument during installation
- Reliable operation, Low maintenance rate

1.2 Application

The MTCMF mass flow meter can be used in the following fields to meet the requirements of ingredient, mixing processes and commercial measurement.

(1) Chemical: containing chemical reaction system
(2) Petroleum: moisture content analysis
(3) Lipids: including vegetable oils, animal fats and other oils
(4) Pharmaceutical
(5) Painting
(6) Paper making
(7) Textile printing and dyeing
(8) Fuel: crude oil, heavy oil, coal slurry, lubricant and other fuels.
(9) Food: gas dissolving beverage, health drink and other liquid.
(10) Transportation: pipeline liquid measurement.
(11) Low temperature fluid, like liquid oxygen and liquid nitrogen, the low temperature up to -200℃
(12) High temperature fluid, the maximum temperature up to 300℃
(13) High pressure fluid, like slurry flow measurement for oil drilling cementing

1.3 Working Principle

If a pipe is rotated around a point (P) while liquid is flowing through it (toward or away from the center of rotation), that fluid will generate an inertial force, with reference to Figure 1.1:

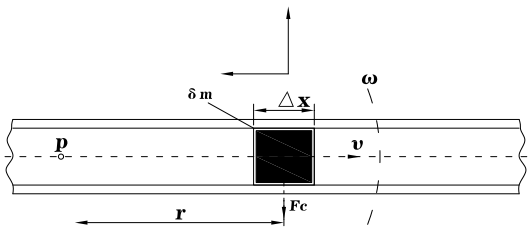


Figure 1-1

A particle (δ_m) travels to the right at a constant velocity (v) inside a tube. The tube is rotating around a fixed point (P) at angular velocity (w), in this case, this particle will get two acceleration components:

1. Normal acceleration (centripetal acceleration), its value is equal to w^2r, its direction is toward the point P
2. Tangential acceleration a_1 (Coriolis acceleration), its value is equal to 2wv, its direction is perpendicular to v

The force generated by tangential acceleration is Coriolis force, its value is equal to Fc =2wvδm. In figure1.1 fluid $\delta_m=\rho A\times\Delta X$, so Coriolis force can be expressed as:

$\Delta Fc=2\omega\upsilon\times\delta m=2\omega\upsilon\times\rho A\times\Delta X=2\omega\times\delta qm\times\Delta X$

Wherein A is the duct cross-sectional area.

$\delta qm=\delta dm/dt=\upsilon\rho A$

For special rotational pipe, its frequency is constant, ΔFc only depends on δqm. Therefore, directly or indirectly measuring the Coriolis force can be measured mass flow. This is how Coriolis mass flow meter works.

The actual flow sensor can't achieve rotational movement, replace by pipeline vibration. The principle is shown in Figure1.2、Figure1.3、Figure1.4. Both ends of a bend pipe are fixed, and the vibration force is applied to the pipe in an middle of the two fixed points (according to the resonance frequency of pipeline), taking the fixed point as axis, making pipeline vibrate at its natural frequency (w). When no fluid flows through the pipeline, the pipeline is only affected by vibration force, the vibration direction of two half-section of pipeline is the same, no phase difference. When fluid flows, by the influence of fluid medium dot Coriolis force Fc inside the pipeline (In the two half-section of pipeline, Coriolis F1 and F2 are equal in magnitude and opposite in direction Figure 1.2), two half-section of pipeline occur twist in the opposite direction to generate phase difference which is proportional to mass flow. The design of sensor is converting the measurement of Coriolis force to the measurement of phase difference for both sides of the vibrating tube. This is the working principle of Coriolis mass flow meter.

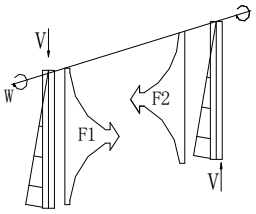


Figure1-2

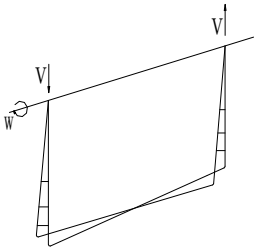


Figure1-3

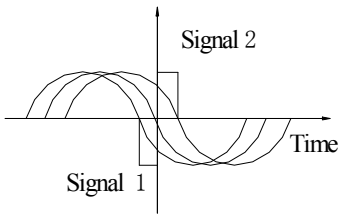


Figure1-4

2 Sensor Structure and Main Parameters

2.1 Sensor Structure as picture below

Figure2-1

The sensor is composed of a measuring tube, a measuring tube driving device, a position detector, a supporting structure, a temperature sensor and a shell.

Main Features

- The measurement signal is large, the measurement accuracy is easy to meet the requirements;
- Small installation stress effect;
- The shell structure has the function of secondary pressure protection and easy to achieve heat preservation;
- Loss of pressure;
- No residual medium, easy to clean;
- Strong vibration resistance;
- Small installation size.

2.2 Model

Model / MTCMF-Z	1	2	3	4	5	6	7	8	9	10	11	Description
Diameter	003											DN3
	006											DN6
	008											DN8
	010											DN10
	015											DN15
	020											DN20
	025											DN25
	032											DN32
	040											DN40
	050											DN50
	080											DN80
	100											DN100
	150											DN150
Structure		C										Compact type
		R										Remote type
Medium temperature			N									-50…+200℃
			H									-50…+300℃
			L									-200…+200℃
Rated pressure				1								1.6MPa
				2								2.0MPa
				4								4.0MPa
				Z								Customized
Power supply					D							DC24V
					A							AC220V
					Z							22-245V
Output signal						R						Pulse/4-20mA/RS485
						H						Pulse/4-20mA/HART
Cable entry							M					M20x1.5
							N					1/2”NPT
							Z					Customized
Accuracy								1				0.1%
								2				0.15%
								3				0.2%
								4				0.5%
Connection									F			Flange
									T			Thread
									C			Tri-clamp
									P			Pipe fittings
									Z			Customised
Explosion										E		Exd[ia]IICT6Gb
										N		Safe environment
Others											Z	Customised

■ **Dimension and Measuring Range**

Size	Flow range	Zero Stability, kg/h
mm	kg/h	kg/h
8	0～960～1440	0.144
10	0～1500～2250	0.225
15	0～3000～4500	0.45
20	0～6000～9000	0.9
25	0～9600～14400	1.44
32	0～18000～27000	2.7
40	0～30000～45000	4.5
50	0～48000～72000	7.2

Note: Flow range gives two parameters, the middle parameter is the standard flow range, generally factory inspection according to this range, and it is also suggested that the user choose the instrument within this range; The latter parameter is the upper flow range to ensure the stable operation of the sensor.

- Accuracy(Liquid) :(With FT-52X Transmitter):
  Measurement accuracy: ±0.1% ±（zero stability/measurement value）%
  Measurement accuracy: ±0.15% ±（zero stability/measurement value）%
  Measurement accuracy: ±0.2% ±（zero stability/measurement value）%
  Repeatability: 1/2 measurement accuracy %
- Density(Liquid) measuring range and accuracy (With FT-52X series transmitter)
  Range: 0.3～3.000g/cm^3 Accuracy: ±0.002g/cm^3
- Temperature measuring range and accuracy (With FT-52X transmitter):
  Temperature measuring range: -50～200℃ Accuracy: ±1℃
- Ambient temperature: －40℃～60℃
- Material : The measuring tube SS316L Housing: SS304
- Working pressure: 0～4.0MPa
- Explosion-proof level : Exd [ia] ⅡC T6Gb

Dimensions and weight

（1）Compact type flow meter Outline diagram

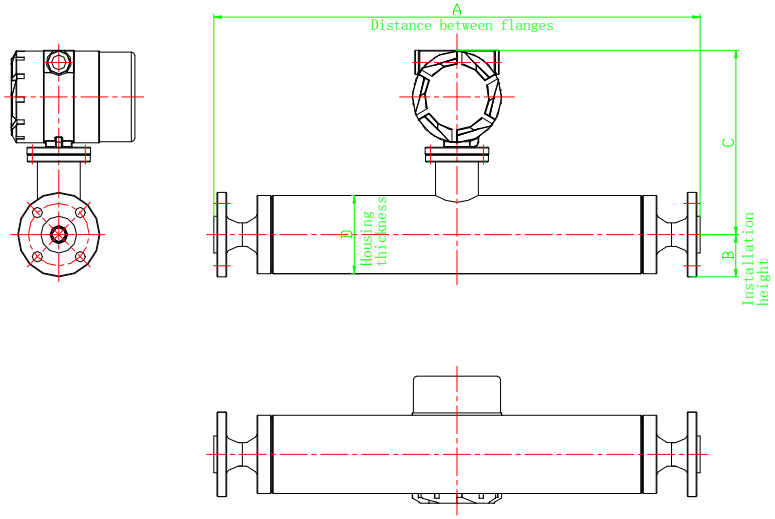


Figure2-1

（2）Compact type flow meter Installation Dimensions

Size	A	B	C	D	Weight
	mm	mm	mm	mm	kg
008	487	44	235.5	82	10
010	537	49.5	236	87	12.5
015	617	52.5	238	87	15
020	680	57.5	251	106.5	17
025	746	70	257	117	23.5
040	952	75	200.5	157	28
050	1042	81.5	279	157	30

3 Selection, Installation and Usage

3.1 Selection

The following conditions should be considered for flow meter selection.

Medium characteristics	▪ Measurability Coriolis mass flow meter is widely used for lots of fluid, but some conditions like slug flow, pulsating flow etc, where you want to install Coriolis mass flow meter, some appropriate support measures must be taken. ▪ Corrosivity Coriolis mass flow meter measuring tube material is SS316L, housing material SS304. If the standard material is not suitable for the medium, anticorrosion wetted material should be selected. ▪ Operating temperature and pressure Standard configuration: -50…+200℃, 4.0MPa, please contact with manufacturer for special parameters. ▪ Ambient condition Standard ambient temperature is -20…+60℃. The flow meter will fail to display if the ambient temperature exceeds the standard range. Please contact with manufacturer for special parameters. ▪ Protection and Explosion Transmitter ex-proof: flame type, Sensor ex-proof: intrinsic type Transmitter and Sensor protection: IP67
Preferred measuring range	1/3~2/3 of standard flow range
Allowable pressure loss	Pressure loss should be considered especially for reduced pipe. Pressure loss reference table is shown as below

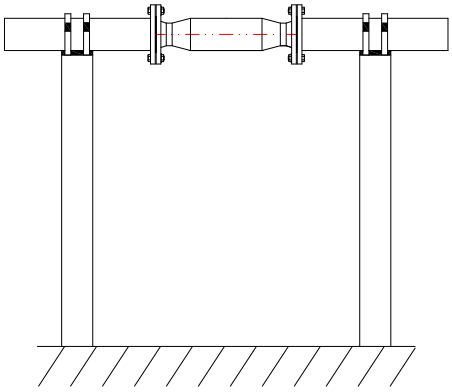
3.2 Installation

3.2.1 Basic Requirements on installation

- Flow direction should be in accordance with MTCMF sensor flow arrow.
- Properly supporting is required for preventing tubes vibrating.
- If a strong pipeline vibration is inevitable, it is recommended to use a flexible tube to isolate the sensor from the pipe.
- Flanges should be kept parallel and their center points should be located on the same axis to avoid subsidiary force generation.
- Installation vertically, make the flow from the bottom up when measuring, meanwhile, the meter should not be installed on the top to prevent air getting trapped inside the tubes.

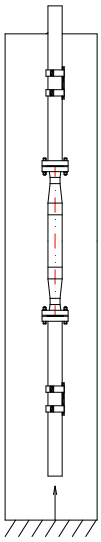
3.2.2 Installation Direction

When measure liquid medium
in general condition the vibration tube should be installed horizontally on the ground .
In order to avoid gas accumulation in the vibration tube, effect measurement



3-1

If there may be particulate things in the measuring medium avoide stored in the vibration tube, vertical installation should be adopted in order to avoid the accumulation of particulate matter in the vibration tube, affects normal measurement.



3-2

3.2.3 Sensor Fixed

Coriolis mass flowmeter is a vibrating instrument, when they work, the two vibrating tube is always in a state of vibration. Therefore, external vibration or pipeline vibration may have effect on their normal operation.
Therefore, when the sensor is installed, the two ends of the sensor should be fixed with a bracket (the connected part should be fixed, and the vibration tube should be in a free state).
Like 3-1 3-2 above please make sure that the installation bracket is installed on a stable interface.

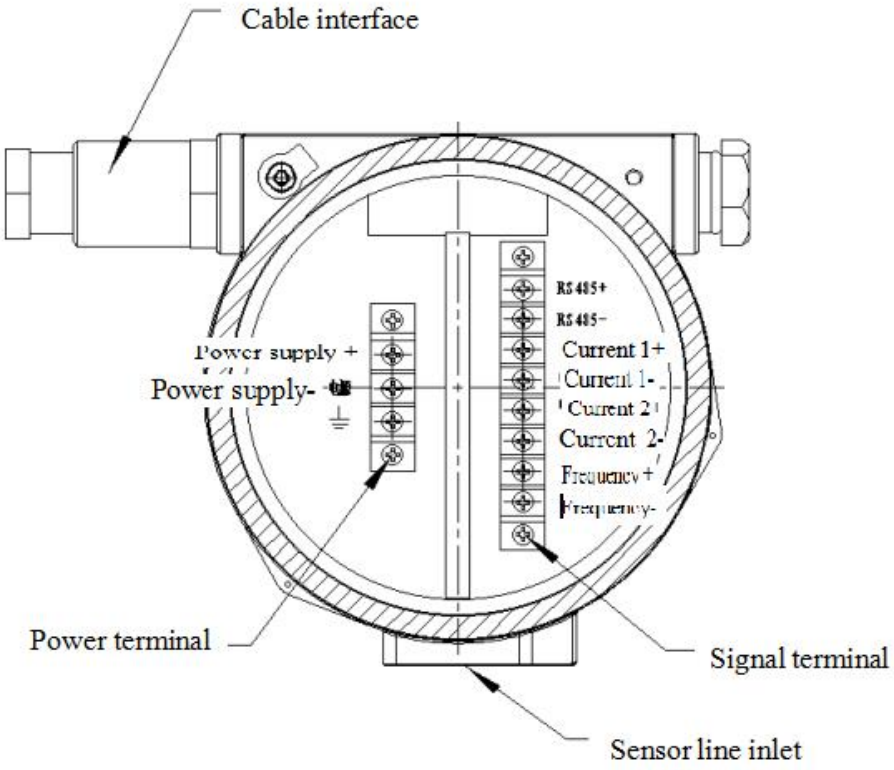
If the fixed bracket cannot be guaranteed, or the pipeline connection cannot be guaranteed to avoid vibration.
Consider mounting the sensor on a stable interface and connecting the sensor to the pipeline with flexible tube.

3.2.4 Terminal and Wiring

Table show the name of terminals, Figure show the wiring method, Current 2 have HART （optional）

The 1st line signal terminals	Signal Descriptions
1	RS485+
2	RS485-
3	Current output 1+
4	Current output 1-
5	Current output 2+
6	Current output 2-
7	Frequency output +
8	Frequency output -
The 2nd line signal terminals	Signal Descriptions
1	Power +
2	Power -
3	Shielding Grounding

Table Wiring terminal definition



3-3 Diagram

3.2.5 Explosion-proof converter

When the instrument is used in explosion-proof occasions, explosion-proof instrument must be used to ensure safety.

The main explosion-proof form of FT-52X series converter is flameproof type, and the connection part with the sensor is installed with essential safety measures to ensure the explosion-proof performance of the sensor.

The converter housing is aluminum alloy housing. The connection between the outer cover of the terminal and the body, the connection between the outer cover of the display operation part of the converter and the body, and between the display window and the shell of the converter are provided with a silicone rubber sealing ring.

External wiring cables (power supply and signal output cables) of the converter shall be 8mm in diameter. The cable is connected to the table through the M20×1.5 pressing nut, gasket and cable sealing apron. After wiring, the nut should be locked to ensure the cable sealing.

A safety barrier is installed at the outlet of the connection line between the converter and the sensor to ensure the explosion-proof performance of the sensor.

For explosion-proof safety, the sealing structure of the flowmeter should not be damaged in use.

When the converter needs to open the cover, the instrument power must be disconnected first. It is forbidden to open the cover under the energized state of the converter. When the cover is closed again, the seal of the converter must be ensured, and the power can only be energized after checking and confirming.

The sensor housing should be grounded nearby, and the cross-sectional area of the wire should not be less than 1 square millimeter.

3.3 OPERATION OF MTCMF MASS FLOW METER

3.3.1 Zero adjustment

In the system menu, select "Basic Settings > Input Password > Zero Calibration

Normally, factory has finished zero adjustment, the users do not need to adjust zero at the field. But some time incorrect installation will cause great stress to make zero change, in this case, zero adjustment at the field is necessary. The requirement on the zero adjustment as below:
Make the measured fluid flow through the meter for 10 minutes;
Close the downstream and upstream valve after the pipe is full of fluid;
Make sure the fluid is static.

3.3.2 Operation and maintenance of flow meter

The mass flowmeter is determined by its structure characteristics and generally does not need special maintenance in use. However, appropriate maintenance measures should be taken to ensure the accurate and reliable operation of the flowmeter under some special operating conditions. Such as:

When particles in the fluid may accumulate in the vibration tube, they should be checked and excluded regularly to avoid affecting the normal use of the flow meter.

When the measuring medium may adhere to the inner wall of the vibration tube, it should be regularly purged to avoid affecting the normal use of the flow meter.

When measuring particles in the medium and may wear the vibration tube, it should be checked and treated in time.

3.3.3 Common faults and treatment

In the process of initial installation and use, if the flowmeter is found to work abnormal, the fault reason should be determined.

The cause of the failure can be divided into two types: application problems and flow meter system problems. The application problem is more complex, such as the measurement fluctuation error caused by process and medium state change, should be analyzed according to the actual situation.

Common Troubleshooting Table

Fault phenomenon	Reason	Solution
Large zero drift	1. Whether the medium in the flowmeter is full of tube and does not flow 2. Whether the installation pipeline of the flowmeter is fixed, and whether there is strong source or frequency converter interference nearby 3. The sensor is installed with stress	1. Make the flow meter full of liquid , close the valve at both ends of the flow meter 2. Add holder or use flexible pipe connection 3. The connection pipe is coaxial with the flowmeter
Instantaneous flow error	1. Whether the actual flow range exceeds the maximum set range of the flowmeter 2. Whether the installation pipeline of the flowmeter has strong vibration 3. Check whether the zero of the flow meter is normal 4. Check the FO and DP value to see if the flow meter is problem or not	1. Reduce pipe flow or reset meter flow range 2. Add holder or use flexible pipe connection 3. Calibrate zero 4. If the flow meter problem ,contact with factory
Density shows instability	1. Check the FO value in the converter or MODBUS,(Normal vavlue ＞50HZ，and stable) 2. Check whether the sensor pin parameters are normal	1. Check if there is bubble in the pipe and find the reason (The installation position of the regulating valve is not correct) 2. If problem please contact with factory
Flow meter no display	1. Check the power supply is normal or not 2. Measure whether the 24V power supply of the junction plate is normal	Check the power supply voltage and wiring terminals to ensure the normal operation of 24V power supply
Communication no signal	Check the communication line for reverse connection or short connection	Check the wiring or AB switch the wiring