

## FMM600 Coriolis Mass flowmeter/Densitometer

## OVERVIEW

The mass flow meter/Densitometer uses the Coriolis effect principle. By measuring the Coriolis force of fluid received in the tube, it can directly measure the mass flow of the fluid in the tube. The Coriolis force is only related to the mass and speed of the fluid. In principle, it eliminates the influence of temperature, pressure, fluid state, density and other parameters on the measurement accuracy, and directly obtains the accuracy flow value and density value of various media under complex environmental conditions. It doesn't need to go through the conversion of intermediate parameters, avoiding measurement errors due to the intermediate conversion, so as to realize the high-precision and accurate measurement.



## CORIOLIS FORCE WORKING PRINCIPLE

The Coriolis effect, referred to as the Coriolis force, is a description of the offset of the linear motion of a mass point in a rotating system due to inertia relative to the linear motion of the rotating system.

Mass flowmeter is a typical application of Coriolis force. It allows the fluid to be measured to pass through a vibrating measuring tube. The flow of the fluid in the pipeline is equivalent to linear motion. The vibration of the measuring tube will generate an angular velocity. Driven by an external electromagnetic field, it has a fixed frequency, so the Coriolis force of the fluid in the pipeline is only related to its mass and velocity, and the product of mass and velocity, that is, the flow velocity, is the mass flow that needs to be measured. The Coriolis force of the fluid in the pipe can measure its mass flow.

## MAIN FEATURES

**1. High mass accuracy - measurement error is better than  $\pm 0.05\%$** 

Through the optimization of the structural parameters of the mass flowmeter sensor and the application of digital technology in the transmitter, the mass measurement error of the FMM600 series mass flowmeter is better than  $\pm 0.05\%$ , The repeatability is better than  $\pm 0.025\%$ .

**2. High density accuracy - measurement error is better than  $\pm 0.0005\text{g/cm}^3$** 

The FMM600 series mass flowmeter realizes direct online real-time measurement of density, which is safe, convenient and reliable, eliminating the disadvantages of manual measurement and improving the work efficiency of operators.

**3. High temperature accuracy - measurement error is better than  $\pm 0.2^\circ\text{C}$** 

FMM600 series mass flowmeter adopts pt100 temperature sensor, combined with precision measurement circuit and advanced temperature compensation algorithm, to provide reliable guarantee for accurate measurement of flow and density.

**4. Good zero-point stability--guarantee long-term stable operation**

Zero point stability is an important indicator to evaluate the measurement accuracy and long-term stability of mass flowmeters.

The FMM600 series mass flowmeter adopts the original technology with national invention patent and American invention patent, which makes the product itself have ultra-high zero-point stability, even in harsh conditions. Under working conditions, it can also run accurately and stably for a long time.

**5. Fast response time -- suitable for small batch, short-time filling**

The FMM600 series mass flowmeter transmitter uses digital algorithms to improve the sampling rate, greatly shorten the response time, and ensure the filling consistency of small batches and short periods of time.

**6. Wide range ratio - the range ratio can reach 30:1**

FMM600 series mass flowmeters use digital algorithms to filter out more noise and ensure the measurement accuracy of low flow rates. The turndown ratio can reach 20:1.

**7. Long service life - product design service life is 10 years**

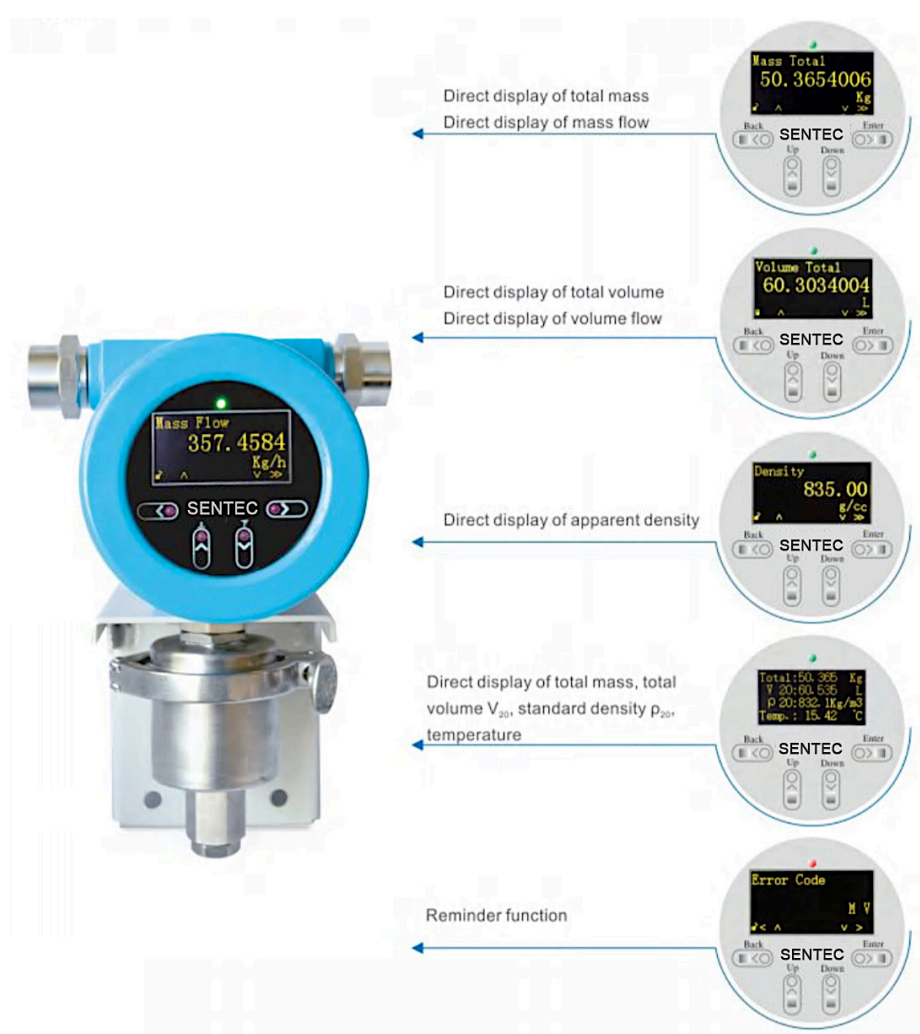
The gears, rotors and other components of traditional volumetric flowmeters are easily affected by fluid erosion and need to be cleaned or replaced regularly.

The principle of the FMM600 series mass flowmeter determines that there are no obstructions and moving parts inside, and there is no wear and tear, which fully guarantees the service life of the mass flowmeter and accurate measurement.

At the same time, the maintenance cost is greatly reduced, saving time, effort and worry.

**8. Others - more warning functions**

The FMM600 series mass flowmeter transmitter can measure more variables and achieve more accurate status indication, such as the reminder of gas-liquid two-phase flow status.



**TECHNICAL SPECIFICATIONS RELATED TO ACCURACY**

	Model	Flange	Mass(kg/h)	Volume(l/h)
Maximum flow	FMM600-K010	DN10, DN15, DN20, DN25	96	110
	FMM600-K015	DN10, DN15, DN20, DN25	270	310
	FMM600-K025	DN15, DN20, DN25	1000	1420
	FMM600-K050	DN15, DN20, DN25	3000	4200
	FMM600-K100	DN25, DN32	15200	21600
	FMM600-K200	DN40, DN50, DN65	52500	75000
	FMM600-K300	DN80, DN100	155000	220000
	FMM600-K350	DN100, DN125, DN150	290000	403000
	FMM600-K400	DN150, (DN175), DN200	462000	652000
	FMM600-K600	DN200, (DN225), DN250	900000	1463000
	FMM600-K800	DN200, (DN225), DN250	1604000	2350000
	FMM600-K1200	DN250, DN300, DN350	2380000	3266000

Mass flow error <sup>①</sup>	Within 30: 1 range ratio <sup>②</sup>	±0.1%
	Within 40: 1 range ratio <sup>②</sup>	±0.15%
Mass flow repeatability	Within 30: 1 range ratio	±0.025%
Volume flow error <sup>③</sup>	Within 30: 1 range ratio	±0.1%

	Model	kg/h
Zero Stability <sup>④</sup>	FMM600-K010	0.0024
	FMM600-K015	0.00675
	FMM600-K025	0.025
	FMM600-K050	0.075
	FMM600-K100	0.38
	FMM600-K200	1.31
	FMM600-K300	3.88
	FMM600-K350	7.83
	FMM600-K400	21.95
	FMM600-K600	29.25
	FMM600-K800	64.16
	FMM600-K1200	99.25

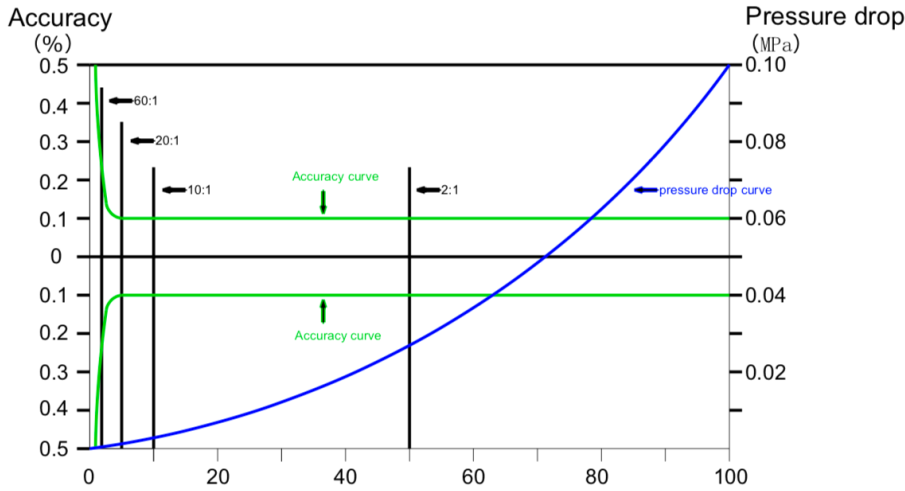
①The stated flow error includes the combined effects of repeatability, linearity and hysteresis. All liquid indicators are based on water at 20 ~ 25°C and 0.1 ~ 0.2Mpa reference conditions, unless otherwise stated.

②Range ratio is the ratio of maximum flow and minimum flow.

③The volume flow error is based on the process fluid with a density of 1g / cm<sup>3</sup>. For process fluids with a density other than 1g / cm<sup>3</sup>, the volume flow is equal to the mass flow divided by the fluid density.

④When the flow value is close to the low end of the flow range, the accuracy of the flow meter begins to deviate from the stated accuracy. At this time, the zero point stability must be considered. The zero point stability is measured under the condition of no installation stress.

**Typical Accuracy, Flow and Pressure Drop Curve**



Range ratio	60: 1	30: 1	10: 1	2:1	1:1
Accuracy(±%)	0.25	0.1	0.1	0.1	0.1
Pressure drop(Mpa)	~0	0.0003	0.001	0.026	0.1

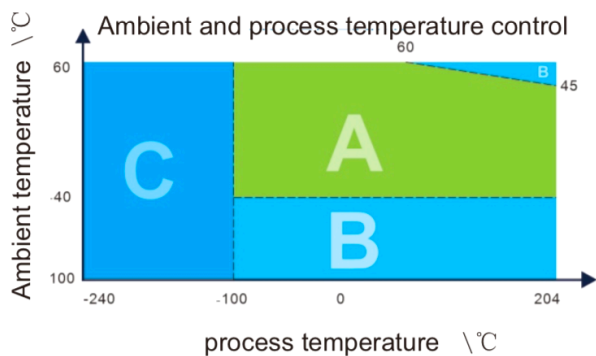
①Accuracy is the actual measurement accuracy. Since the highest accuracy of "JJG 1038-2008 Coriolis Mass Flow Meter" is 0.15, the relevant certificates and qualifications can only be 0.15.

**DENSITY ACCURACY (FOR LIQUID)**

Density error	±0.0005g/cm <sup>3</sup>	±0.5kg/m <sup>3</sup>
Repeatability	±0.0001g/cm <sup>3</sup>	±0.1kg/m <sup>3</sup>
Measuring range	(0.2~2.0)g/cm <sup>3</sup>	(200~2000)kg/m <sup>3</sup>

②Density error includes the combined effects of repeatability, linearity and hysteresis. The density error of ± 0.0005g / cm<sup>3</sup> ( ± kg / m<sup>3</sup> ) is based on water under the reference conditions of 20°C and 0.1 ~ 0.2Mpa. Under different operating conditions, accuracy may be reduced.

**TEMPERATURE ACCURACY**





Error	±0.2°C	
Repeatability	±0.1°C	
Temperature limit <sup>①</sup>	Temperature range (-240~204)°C	
①If installed in a hazardous location, the explosion-proof certification shall define the applicable temperature range.		
Temperature display range	(-240~204)°C	Pt100 temperature measurement
Process medium temperature	Integral	(-40~80)°C
	Four-wire system(separate type)	(-40~80)°C
	Nine-wire system(separate type)	(-240~204)°C
Ambient temperature	Operating temperature	(-40~60)°C
	Storage temperature	(-40~70)°C

### GENERAL SPECIFICATION

Powersupply	AC power supply	(85~265)VAC, 50/60Hz
	DC power supply	(18~100)VDC
Pressure resistance and sealing	The compressive strength test was carried out on the pressure part of the flow meter with water, and the test pressure was 1.5 times the nominal pressure, which lasted 5 minutes, and there was no leakage at each connection.	

### OUTPUT SIGNAL AND INTEGRATION

Analog communication (two optional output channels)	It can be set according to site requirements: two channels current communication, two-way pulse communication or one-way current communication and one-way pulse communication.	
Pulse output	Output range	(0~10)kHz
	Basic error	±0.01%
	Temperature influence	±0.001% F.S/°C
Current output	Output range	(4~20)mA
	Basic error	±0.05%
	Temperature influence	±0.005% F.S/°C
Digital communication	RS485 interface, Modbus communication protocol; optional baud rate: 9600, 19200 or 38400, etc.; multi-machine communication and bus connection are available.	
Powerconsumption	BPM Transmitter maximum power ≤11W	

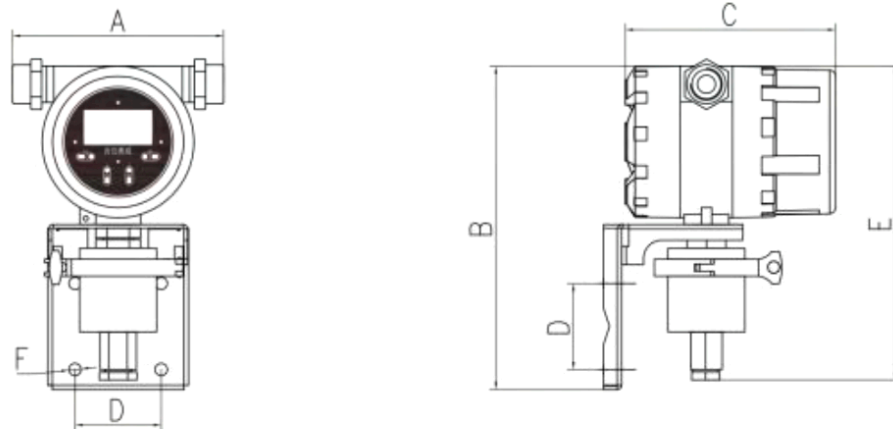
**HAZARDOUS AREA CLASSIFICATIONS**

	Explosion-proofmark	
Explosion-proofgrade	Sensor	Exib IICT1~T6 Gb
	Transmitter	Ex d [ib] IICT4 Gb
	Explosion-proof performance conforms to GB3836.1-2010, GB3836.2-2010, GB3836.4-2010	
	Application:suitable for Zone 1 and Zone 2 of explosive hazardous locations, equipment category IIC, backward compatible with IIA, IIB, temperature group T1~6	
Protection level	Sensor	IP67
	Transmitter	IP65

**INSTALLATION DIMENSION**

• **Transmitter dimension**

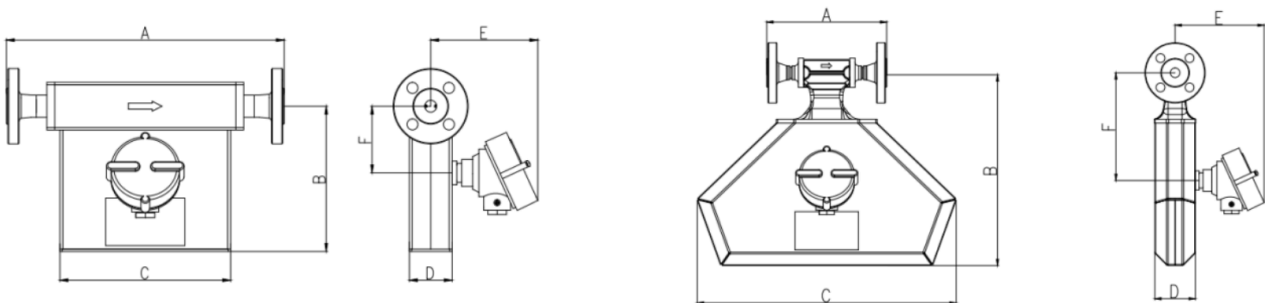
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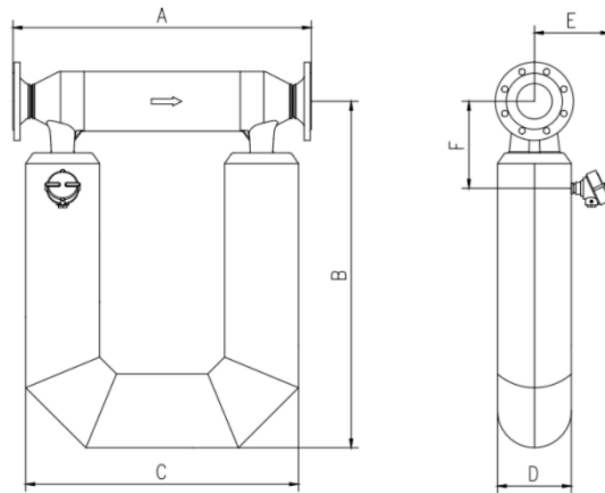


Transmitter model	A	B	C	D	E	F
FMM	166	71	204	284	71	294

• **FMM600 Mass Flow Meter Installation Dimensions (Separate Type)**

(unit:mm)

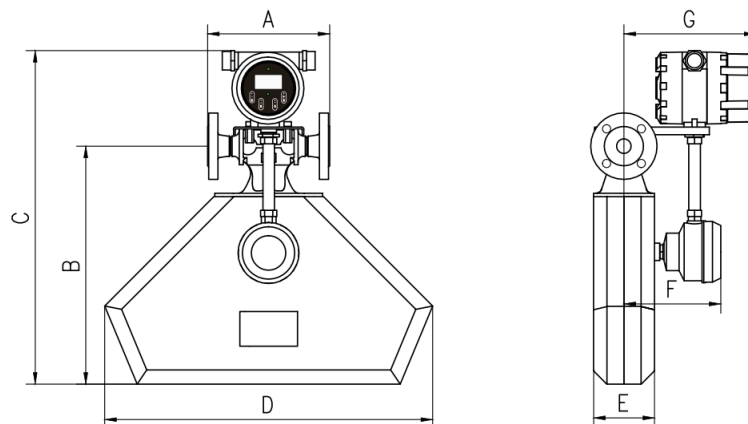


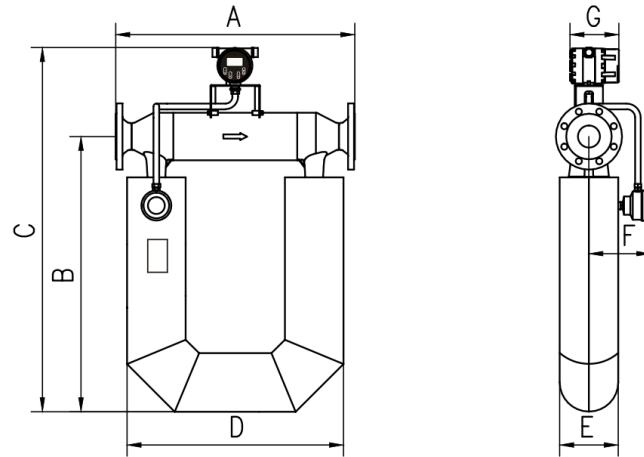


Types	Model	Specification	A(Customizable)	B	C	D	E	F
Δ	FMM600-K025	DN15/DN20/DN25	161~165	219	279	53	135	107
	FMM600-K050	DN15/DN20/DN25	189~193	303	408	64	140	169
	FMM600-K100	DN25/DN32	212~216	412	568	106	167	185
U	FMM600-K010	DN10/DN15/DN20/DN25	345~355	183	216	54	137	84
	FMM600-K015	DN10/DN15/DN20/DN25	345~355	183	216	54	137	84
	FMM600-K200	DN40/DN50/DN65	582~596	727	496	140	186	204
	FMM600-K300	DN80/DN100	836~866	976	768	208	220	245
	FMM600-K350	DN100/DN125/DN150	830~876	841	718	212	222	226
	FMM600-K400	DN150/ (DN175) /DN200	990~1056	1095	860	300	260	300
	FMM600-K600	DN200/ (DN225) /DN250	1004~1090	1211	850	379	305	245
	FMM600-K800	DN200/ (DN225) /DN250	1004~1090	1326	850	410	321	245
	FMM600-K1200	DN250/DN300/DN350	1090~1130	1641	850	506	369	245

• FMM600 Mass Flow Meter Installation Dimensions (Integral Type)

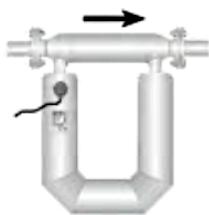
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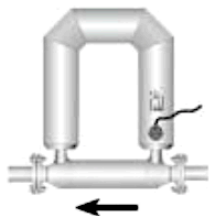
Types	Model	A(Customizable)	B	C	D	E	F	G
FMM600-K100	DN25/DN32	212~216	412	578	568	106	167	229
FMM600-K200	DN40/DN50	582~596	727	1003	496	140	186	174
FMM600-K300	DN80/DN100	836~866	976	1292	768	208	220	174
FMM600-K350	DN100	830~876	841	1150	718	212	222	174
FMM600-K400	DN150/DN200	990~1056	1095	1391	860	300	260	174
FMM600-K600	DN200/ (DN225) /DN250	1004~1090	1211	1578	850	379	305	174
FMM600-K800	DN200/ (DN225) /DN250	1004~1090	1326	1693	850	410	321	174
FMM600-K1200	DN250/DN300/DN350	1090~1130	1641	2008	850	506	369	174

### INSTALLATION PRECAUTIONS



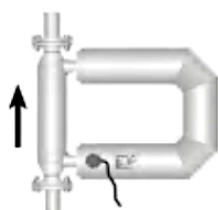
#### **Horizontal installation—bottom mounted** **Applicable medium: liquid**

**!** Generally, the sensor is installed with the shell facing down to prevent air from accumulating in the sensor measurement tube, thereby achieving the purpose of accurately measuring the mass flow.



#### **Horizontal installation—top mounted** **Applicable medium: gas**

**!** Generally, the sensor is installed with the shell facing upward to avoid the accumulation of condensate in the measuring tube of the sensor.



#### **Flag installation—side mounted** **Applicable medium: liquid or solid-liquid mixing**

**!** Generally, the sensor is installed on the vertical pipeline to avoid the accumulation of particles in the measuring tube of the sensor.

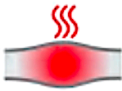
NOTES ON INSTALLATION LOCATION



The sensor should be away from interference sources that can cause mechanical vibration of the pipeline, such as the pump on the process pipeline.



The measuring tube of the sensor should always be filled with liquid and have a certain back pressure, which requires the installation position to be at the lower end of the pipeline.



The sensor should pay attention to the expansion and deformation of the process pipeline due to temperature changes, especially cannot be installed near the expansion joint of the process pipeline.



The sensor flange must be coaxially connected to the pipeline flange to ensure no installation stress.



The sensor should be far away from industrial electromagnetic interference sources, such as high-power motors, transformers, etc. .



The upstream and downstream of the sensor should be installed with shut-off valves respectively.

- ⚠ When installing the sensor, you must choose a suitable installation location. In order to eliminate the impact of vibration on the measurement, in addition to staying away from the vibration source, a support rod is also required to fix the pipeline and valve firmly during installation. The lower end of the support rod must be fixed on a stable foundation, and the upper end is matched with the pipe clamp to fix the process pipeline. (Do not use the sensor housing to support sensors, pipelines, valves, pumps, etc.)
- ⚠ After the sensor is installed, its housing should be in a free floating state.

CALIBRATION SYSTEM



The key components of the calibration system all use the best original imported equipment: weighing instrument-METTLER TOLEDO's highest-precision electronic scale to ensure calibration accuracy; water pump- Grundfos variable frequency control water pump to ensure stable flow rate.



Obtained the verification certificate of "Static Mass Water Flow Standard Device" issued by the National Institute of Metrology of China.



APPLICATIONS

<p>Application in mass custody transfer</p>	<p>Application in standard volume (V20) handover</p>	<p>Application in quantitative loading</p>
<p>The mass measurement error of FMM series mass flow meter is less than 0.1%, with high stability and can realize custody transfer.</p>	<p>The mass measurement error of the FMM Series Mass Flow Meter is less than 0.1%, the density measurement error is less than 0.0005 f cm, the temperature measurement error is less than 0.2 °C, and the measurement error of the standard volume (V<sub>0</sub>) is guaranteed to be less than 0.15%.</p>	<ol style="list-style-type: none"> <li>1. The measurement error of the mass flow meter is less than 0.1% to achieve accurate loading and improve loading efficiency;</li> <li>2. The measurement accuracy is not affected by changes in medium density,</li> </ol>
<p>Application in ultra-low temperature medium</p>	<p>Application in high temperature and high viscosity media</p>	<p>Application in batch filling</p>
<p>FMM Series Mass Flow Meters can be applied to ultra-low temperature media such as LNG and liquid nitrogen with a temperature not lower than -240°C</p>	<p>FMM Series Mass Flow Meters can be applied to high temperature and high viscosity media such as maleic anhydride, residual oil, crude oil, resin, maltose etc., whose temperature is not higher than 204°C</p>	<p>The flow response time of FMM Series Mass Flow Meter is 50ms, and the response speed is fast, which ensures the consistency of batch filling.</p>
<p>Application in gas measurement</p>	<p>Application in density measurement</p>	<p>Application in high-power equipment fuel detection</p>
<p>FMM Series Mass Flow Meters can be used to measure gas under high pressure, high flow rate and other working conditions.</p>	<p>FMM Series Mass Flow Meters have no choke or moving parts, its pipeline is wear resistance and its density measurement accuracy is high. It is suitable for the measurement of parameters such as lime slurry concentration, pulp concentration, ammonia concentration, alcohol content, sugar Baume degrees and water content.</p>	<p>FMM Series Mass Flow Meters has a wide range ratio, fast response speed, strong anti interference ability and can detect intermittent flow, suitable for fuel monitoring of large equipment, such as marine fuel monitoring and large equipment fuel consumption monitoring,</p>