

# Massflow Meter

A practical guide to massflow meter, covering the reader intent, the relationship to massflow meter, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.



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In industrial process control, the precise measurement of material movement is critical for quality assurance, safety, and economic efficiency. While volumetric flow measurement has been the traditional standard, the industry has increasingly shifted toward the use of the massflow meter. Unlike volumetric devices, which measure the space a fluid occupies, a massflow meter measures the actual mass of the substance passing through a system. This distinction is vital because mass remains constant regardless of changes in temperature, pressure, or density, whereas volume fluctuates significantly under varying process conditions.

For engineers and plant managers, understanding the mechanics, selection criteria, and installation requirements of mass flow technology is essential for optimizing modern production lines. This guide provides a technical overview of massflow meter technologies, focusing on Coriolis and thermal dispersion principles, to assist in the selection of the most appropriate instrumentation for industrial applications.

## **| Principles of Mass Flow Measurement**

To select the correct instrument, one must first understand the physics governing the two primary types of massflow meters used in B2B industrial environments: Coriolis and Thermal Mass Flow.

## **| The Coriolis Principle**

Coriolis massflow meters are considered the "gold standard" for direct mass measurement. They operate based on the Coriolis effect, a phenomenon of Newtonian mechanics. Inside the meter, one or two measuring tubes are vibrated at their resonant frequency by an electromagnetic drive coil. When a fluid (liquid or gas) flows through these vibrating tubes, it induces a secondary vibration—a twisting or phase shift—due to the Coriolis force.

This phase shift is directly proportional to the mass flow rate. Sensors located at the inlet and outlet of the tubes detect the time difference ( $\Delta T$ ) between the vibrations. Because this measurement is based on inertia and motion rather than volume, it is unaffected by changes in fluid viscosity, density, or flow profile. Additionally, Coriolis meters can simultaneously measure fluid density by monitoring the resonant frequency of the tubes, making them highly versatile for complex process monitoring.

## **| The Thermal Dispersion Principle**

Thermal massflow meters are primarily utilized for gas applications. They operate on the principle of heat transfer. A typical thermal meter consists of two temperature sensors: one is a reference sensor that measures the ambient temperature of the gas, and the other is a heated sensor maintained at a constant differential temperature above the reference.

As gas flows past the heated sensor, it carries away heat (thermal dispersion). The amount of energy required to maintain the constant temperature differential is directly proportional to the mass flow rate of the gas. This relationship is often defined by King's Law. Because the cooling effect depends on the number of gas molecules (mass) hitting the sensor rather than the volume, the meter provides an accurate mass flow reading without requiring separate pressure or temperature compensation.

## **| Technical Selection Criteria**

Selecting a massflow meter requires a detailed analysis of the process fluid and the environmental conditions. Engineers must evaluate the following parameters to ensure long-term reliability and accuracy.

## | Fluid Phase and Composition

Coriolis meters are exceptionally versatile, capable of measuring liquids, gases, and even slurries or high-viscosity fluids like resins and oils. However, they can struggle with fluids containing high percentages of entrained air or large bubbles, which can dampen the tube vibrations. Thermal massflow meters are almost exclusively used for clean gases. They are not suitable for liquids or gases containing moisture droplets, as the liquid phase would cause erratic cooling of the heated sensor, leading to significant measurement errors.

## | Accuracy and Turndown Ratio

Accuracy requirements often dictate the choice of technology. Coriolis meters typically offer high precision, often within  $\pm 0.1\%$  to  $\pm 0.05\%$  of the flow rate. They also feature a high turndown ratio (the ratio between maximum and minimum measurable flow), often reaching 100:1 or higher. Thermal meters generally provide accuracies in the range of  $\pm 1\%$  of reading plus  $\pm 0.5\%$  of full scale, with turndown ratios around 50:1, making them ideal for detecting leaks or measuring low-velocity gas flows in large ducts.

## | Pressure and Temperature Limits

Coriolis meters are robust and can handle high-pressure applications (up to 350 bar or more) and wide temperature ranges (from cryogenic  $-200^{\circ}\text{C}$  to  $+350^{\circ}\text{C}$ ). Thermal meters are more limited by the physical constraints of the sensor probes and are typically used in lower-pressure gas lines, though high-pressure versions are available for specific industrial gases like compressed air or nitrogen.

## | Practical Selection Table

The following table summarizes the key differences between the primary massflow meter technologies and traditional volumetric alternatives.

| Feature           | Coriolis Mass Meter      | Thermal Mass Meter        | Volumetric (Vortex/Turbine) |
|-------------------|--------------------------|---------------------------|-----------------------------|
| Primary Target    | Liquids, Slurries, Gases | Clean Gases, Air          | Liquids, Steam, Gases       |
| Measurement       | Direct Mass              | Calculated Mass (Thermal) | Volume Flow                 |
| Accuracy          | ±0.1% (High)             | ±1.0% (Medium)            | ±1.0% to ±2.0%              |
| Pressure Drop     | Moderate to High         | Very Low                  | Moderate                    |
| Straight Run Req. | None (0D/0D)             | High (10D/5D)             | High (15D/10D)              |
| Initial Cost      | High                     | Moderate                  | Low to Moderate             |
| Maintenance       | Low (No moving parts)    | Low (Periodic cleaning)   | Moderate (Wear parts)       |

## Installation Considerations

Proper installation is as critical as device selection. Even the most advanced massflow meter will fail to provide accurate data if installed incorrectly.

## Piping and Orientation

For Coriolis meters, straight pipe runs are generally not required, which is a significant advantage in cramped industrial layouts. However, orientation is vital. For liquid applications, the meter should ideally be installed in a vertical pipe with upward flow to ensure the tubes remain full and to prevent air entrapment. For gas applications, the tubes should point downward to prevent condensate from collecting in the measuring section.

Thermal massflow meters, conversely, are highly sensitive to the flow profile. They require significant straight pipe runs (typically 10 diameters upstream and 5 diameters downstream) to ensure a stable, laminar flow profile. If space is limited, flow conditioners or rectifiers must be installed to prevent turbulence from skewing the thermal dispersion readings.

## | Vibration and Support

Because Coriolis meters rely on high-frequency vibrations, they must be isolated from external mechanical vibrations. High-power pumps or vibrating machinery located near the meter can interfere with the sensor's frequency, leading to "noise" in the data. Robust mounting brackets and flexible couplings are often recommended to decouple the meter from the rest of the piping system.

## | Calibration and Zero-Point Stability

Upon installation, a Coriolis meter must undergo a "zero-point calibration." This involves filling the meter with the process fluid, ensuring there is zero flow, and then running the transmitter's zeroing routine. This accounts for the specific stresses and orientation of the installed piping. Thermal meters often require field calibration if the gas composition differs from the factory calibration gas, as the thermal conductivity varies between different gas species.

## | Limitations and Common Risks

While massflow meters offer superior performance, they are not universal solutions. Engineers should be aware of the following risks:

1. **Pressure Drop:** Coriolis meters, particularly those with U-shaped tubes, can introduce a significant pressure drop in the system. This must be accounted for in pump sizing and system hydraulics.
2. **Initial Capital Expenditure:** The cost of a Coriolis massflow meter can be five to ten times higher than a simple magnetic or turbine flow meter. The investment is usually justified by the reduction in raw material waste or improved product consistency, but it requires a clear ROI analysis.
3. **Gas Composition Changes:** Thermal mass flow meters are calibrated for a specific gas mixture. If the composition of the gas changes (e.g., a shift in the ratio of Methane to Ethane in natural gas), the heat transfer characteristics change, and the meter will report inaccurate mass flow data unless it is recalibrated or equipped with multi-gas capabilities.

## | Frequently Asked Questions (FAQ)

Q: Can a massflow meter replace a level transmitter for inventory control?

A: While a massflow meter tracks the movement of material into or out of a tank, it cannot account for leaks, evaporation, or initial inventory. For comprehensive inventory management, it is best to use mass flow meters in conjunction with level measurement solutions. You can Review product options and application support to see how these technologies integrate.

Q: Why is mass flow preferred over volumetric flow in the chemical industry?

A: Chemical reactions occur based on molecular ratios (mass), not volume. Since liquids expand and contract with temperature, measuring volume can lead to incorrect dosing. Mass flow ensures that the exact amount of reactant is added regardless of the ambient or process temperature.

Q: Do massflow meters require frequent maintenance?

A: One of the primary benefits of both Coriolis and Thermal meters is the lack of moving parts. This significantly reduces mechanical wear. Maintenance is usually limited to periodic calibration verification and, in the case of thermal meters, ensuring the sensor probes remain free of buildup or coating.

## | Conclusion

The implementation of a massflow meter is a strategic decision that enhances process transparency and control. By measuring mass directly, industrial operators eliminate the variables of pressure and temperature that often complicate volumetric data. Whether utilizing the high-precision Coriolis effect for liquid processing or the efficient thermal dispersion principle for gas monitoring, selecting the right meter involves a careful balance of fluid characteristics, accuracy requirements, and installation constraints.

For those looking to integrate these instruments into a broader process automation strategy, it is essential to consult with manufacturers who understand the interplay between flow and level measurement. To explore a full range of industrial measurement instruments, visit the Main Page of our product catalog. Proper instrumentation is the foundation of industrial efficiency, and choosing the correct mass flow technology is a definitive step toward achieving optimized process outcomes.