Selection Guide

Five Critical Factors in Selecting Flow Meters for Semiconductor Manufacturing

Identifying which flow meter best suits a particular industrial application, specifically semiconductor manufacturing, can be a challenge.

Flow measurement critical to many industries

Measuring the flow of liquids and gases is a critical component of many industrial applications. Unreliable flow measurements can sometimes mean the difference between success and failure. Inaccurate flow measurements – or lack of measurements – may result in potential hazards to humans and the environment. Depending upon the industry, geography, and other factors, flow measurement may also be integral to fulfilling regulatory requirements related to water usage, resource procurement, and waste management.

Any industrial engineer will tell you that a flow meter is simply an instrument that indicates the amount of liquid, gas, or vapor moving through a pipe. This calculus is done by measuring velocity of the medium, Coriolis force, differential pressure, or induced voltage. While reliability and accuracy are clearly critical to flow measurement, identifying which flow meter best suits a particular industrial application, specifically semiconductor manufacturing, can be a challenge.

Semiconductor manufacturing demands reliable flow measurement

Nitrogen, argon, helium, and even compressed air are among the gasses flowing through some pipes of the modern semiconductor fabrication facility. Other conduits carry large quantities of water (low purity, ultrapure and waste) for a variety of purposes ranging from equipment cooling to wafer surface cleaning.

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Reliably measuring the flow of both gasses and liquids is key to avoiding disastrous or costly mistakes.

Today's manufacturers have a choice of numerous types of measurement devices. The benefits of each are only realized if used properly and in the right application. Errors in measurement often begin in the preoperational phase with meter selection. Selecting the wrong flow meter for an application can cause complications down the roadincreasing the potential for high maintenance costs and downtime.

There are plenty of considerations for assessing flow meters and pairing the right instrument to an application. Here are five essential factors that can make the job a little easier.

Factors to consider in evaluating flow meters

1. Installation considerations

Selecting a flow meter to measure the flow rate within a manufacturing facility can be an intricate process. There are many factors to consider. Begin by identifying each location in the fabrication and sub-fabrication environment where flow meters are required. This will help to narrow down the selection options.

The installation of some flow meters can directly impact the production environment. Others, like ultrasonic clamp-on flow meters, are ideal for applications when a system shutdown is not an option. Ultrasonic clamp-on meters use solid-state, ultrasonic measurement technology to measure the flow of all kinds of fluids in a wide range of pipe diameters. This type of technology is particularly valuable when retrofitting existing pipeline infrastructure.

Tolerances for loss of pressure and contamination are other considerations. Invasive flow meters like turbine meters can impact flow or may be adversely affected by the medium. Similarly, the placement of the flow meter in proximity to straight runs, bends, or its proximity to pumps can make a difference in which device will work best. Many flow meters work best on flows coming from a straight run of pipe. Bends, elbows, or tees might demand a Coriolis electromagnetic flow meter, for instance, which can maintain accurate measurements under these conditions.

2. Reliability/Calibration

Measuring the flow of argon, which is critical to supporting plasmas in the deposition phase of chip production, needs to be quantified reliably and repeatedly. So too, it may be with wastewater handling to meet regulatory requirements. Reliability is essential when measuring gaseous precursors entering a vacuum chamber during chemical vapor deposition. While the need for accuracy may vary by degree, depending on application, reliability is always essential to keep the fabrication process up and running. Besides reliability, knowing whether an application requires measurements in mass or volumetric units will be necessary.

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Repeatability is a key consideration in flow meter selection. Manufacturers should be able to describe how consistently a particular meter can accurately measure flow. Accuracy can drop based on flow fluctuation within pipes or if the unit is moved between pipes of varying sizes. Repeatability specifications will help in comparing accuracy specifications among different devices.

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3. Medium

It sounds obvious, but the medium flowing through a particular pipe is likely the most significant consideration in selecting an appropriate flow meter. With their distinct properties, liquid, steam, and gas can shift the selection of measuring devices. For instance, bulk gases such as air, nitrogen, argon, oxygen, and hydrogen compress, so using a liquid flow meter would be inappropriate.

Knowing the composition of the medium is important. If the medium is liquid and contains particulates, it's considered "dirty." Flow meters with moving parts can become bogged by the slurry dirty liquids carry.

Electrical conductivity and aeration within the medium are additional factors to consider, as are its chemical properties. Corrosive and caustic liquids like hydrogen peroxide, sulfuric acid, ammonia, hydrochloric acid, and solvents may damage an intrinsic meter, increasing maintenance costs and replacement frequency.

A final consideration for liquid mediums is viscosity or resistance to flow. Molecular friction is important to understand and will affect how the liquid flows through a pipe (laminar or turbulent), dictating the type of meter required.

4. Temperature, pressure, flow range and pipe size

As important as it is to know what type of medium is being measured, it's also critically important to understand the flow environment. Temperature, pressure, and flow range will affect meter selection. If measurement accuracy is potentially affected by any of those variables, that bears consideration in meter selection. Extreme temperatures may require compensation or sensors of some sort. High-pressure environments can damage moving parts in some flow meters.

Not all flow meters respond well to changes in the rate of flow. Some flow meters will be unreliable in pipes with dynamic flow rates that fluctuate between the minimum and maximum flow. Others will operate without flaw over a wide turndown rate. The proximity of the flow meter to bends, valves, and other junctions will have an additional bearing on flow.

Finding the right flow meter will simplify installation and maintenance down the road.

Similarly, not all flow meters are compatible with all pipe diameters. Appropriately outfitting a semiconductor plant requires that flow meters match the application—in this case, the pipe diameter. Finding the right flow meter will simplify installation and maintenance down the road.

5. Required maintenance

As with any equipment purchase, knowing the recommended maintenance protocols and costs will help schedule downtime and manage budgets. The flow meter manufacturer should be able to help with these decisions. The need to replace moving parts, seals, or sensors may vary with application and can impact uptime for lines.

The properties of the medium can affect maintenance schedules. Corrosive and caustic liquids may mean more frequent checkups are needed. When the properties of the medium are not considered in advance, excessive maintenance or costly replacements may result.

In an age where we've become accustomed to planned obsolescence, a prudent manager should ask about a meter's lifecycle. Expect flow meters with moving parts or those that come in contact with caustic materials to be replaced more often. As you compare different flow meter technologies, be sure to calculate the cost of installation and maintenance. Inherent to understanding maintenance considerations is knowing the availability of spare parts. If parts are in short supply, that may mean taking sections of the plant out of operation for long periods of time.

A final maintenance consideration is serviceability. Meters that can be serviced or replaced by in-house personnel may prove more cost-effective over the long run. Not all flow meters will be end-user serviceable, however. Ask the manufacturer about this option and whether it offers training or other resources to enable your in-house staff to handle routine maintenance.

Ultrasonic flow meters for maximum flexibility

Among flow meter technologies, ultrasonics is one of the fastest growing in many industries because of its reliability, and diagnostic capabilities. The technology is particularly well suited to semiconductor manufacturing. With no moving parts to wear out and no obstruction to the flow, ultrasonic flow meters provide an overall cost of ownership lower than that of other flow meter technologies.

Measuring the flows of liquid mediums, along with gas, is essential to the semiconductor industry's manufacturing processes. Flexibility is necessary, and only ultrasonic flow meters, which are externally mounted (non-intrusive) in this industry, can address the required breadth of conditions. Unlike other instruments, ultrasonic flow meters are not impaired by dirty liquids, viscosity, pipe size, pressure or temperature.

The caustic nature of some mediums can present both health and environmental hazards. Strong acids and copper-laden wastewater, the by-products of chemical mechanical planarization (CMP), are two examples. Invasive technology introduced into the supply and removal lines could cause safety and measurement issues or other hazards. The non-invasive nature of the ultrasonic flow meter provides an altogether safer alternative.

Ultrasonic flow meters capably provide measurements of various fluids and gasses in semiconductor production

Ultrasonic flow meters capably provide measurements of various fluids and gasses in semiconductor production. They are accurate and reliable, making them usable

across environments and mediums. And, since there are no moving parts, the maintenance required on the units is near zero.

Panametrics TransPort Family of ultrasonic, clamp-on meters is one example of a solution that can handle liquid and gas. These meters attach to pipe fixtures to measure the flow within the pipe. Quick installation and meter readings enable users to continue semiconductor manufacturing processes without shutting down. Their portability allows them to be moved to numerous measurement locations, making it easy to spot-check the flow, verify the permanent flow meter, pump or compressor, or temporarily install the device.

For portable liquid applications, a unit like the Panametrics PT900 capitalizes on superior transducer performance. The simplified user interface and installation process of the PT900 mean that users, regardless of their level of experience, can strap the fixture onto the pipe, program the electronics, and be ready to record measurements within 10 minutes. The company's AT600 combines state-of-the-art flow measurement capability for liquid applications with a low-cost transmitter package installed right at the process measurement point.

For gas-specific applications, the company's TransPort PT878GC flowmeter is a highly versatile, self-contained, portable transit-time system with options and accessories to meet a variety of gas flow measurement needs. A fixed-installation solution is found in the Panametrics GC868. The unit's advanced clamp-on ultrasonic transducers and clamping fixtures make this flow meter reliable and easy-to-use in semiconductor manufacturing environments. The GC868 take full advantage of Panametrics' patented transit time techniques for many types of gas process measurements.

About Panametrics

Panametrics, a Baker Hughes business, develops solutions for measuring and analyzing moisture, oxygen, liquid, steam, and gas flow with proven technologies that are well-known and widely deployed across many industries, including oil and gas.

For more than 60 years, we've been constantly evolving our product line to deliver the most effective moisture and gas measurement systems on the planet. Today, the culmination of decades of expertise, insight, and innovation is expressed in our Sentinel portfolio of high-accuracy liquid flow meters that cover a range of operating temperatures and applications.

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