Thermal Mass Flow

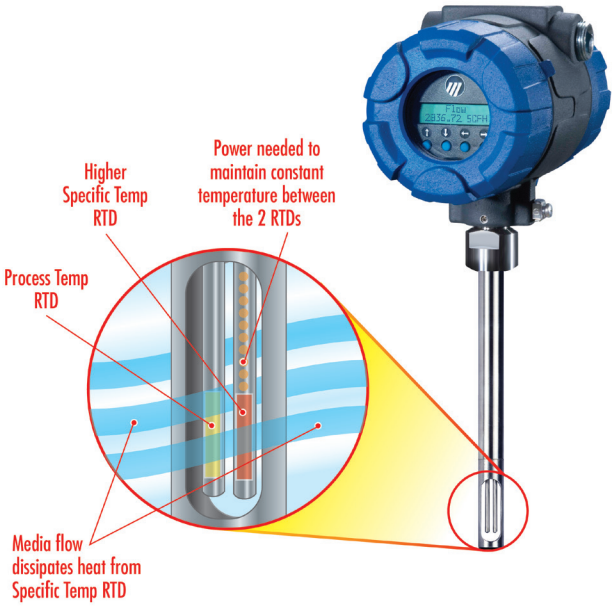
Versatility of Thermal Mass Flow Meters

Magnetrol®

Technology

There are many well documented flow meter technologies that are essentially trying to accomplish the same thing: measure fluid flow rate. Some of the technologies that are entrenched in the market, such as flow meters that utilize differential pressure as the measurement principle, are well understood by customers. Thermal mass flow meters however, such as the Magnetrol® Thermatel® TA2, are a rapidly growing technology that is continuously evolving.

Most flow meters inherently measure a flow rate at operating temperature and pressure, rather than the often desired mass flow rate at standard temperature and pressure (STP). Examples of flow rates at operating conditions are CFM or m3/h. The conversion to mass flow involves measuring operating temperature and pressure as well as knowing the STP conditions. This calculation can be accomplished outside of the flow meter or using a multivariable transmitter. When the term "mass flow meter" is discussed in the instrumentation world it is typically describing a Coriolis flow meter. Similar to Coriolis technology, thermal mass flow meters measure a flow rate at standard conditions (SCFM or Nm3/h) without the need for external measurements or additional calculations.



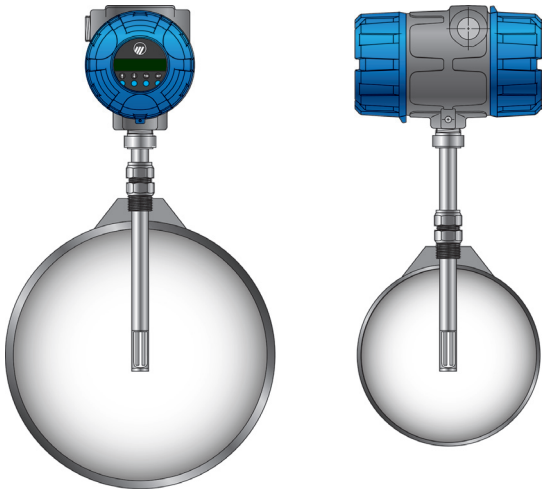
In-depth commentary on thermal dispersion technology or the principle behind thermal mass flow meters is readily available, but these conversations should emphasize that it is simply another method of measuring flow (primarily gas flow). It is no more or less complicated than other flow meter technologies and it is not "black magic." Orifice plates utilize differential pressure to enable flow measurement, turbine meters rely on rotor rotation and thermal mass meters measure flow by heat transfer. Some of the key advantages of using thermal include direct mass flow measurement, high sensitivity at low flow rates, and no moving parts in the line.

Installation Versatility

Installation is key for flow meters to perform as accurately as possible. Each technology has unique guidelines for positioning and straight run. Owning a technology that allows for greater flexibility will save on installation and maintenance costs over the life of the flow meter.

In the case of thermal, the sensors can be provided as inline or insertion type. With insertion probes it is very common to utilize a compression fitting. This fitting will thread into a half coupling or threadolet off of the pipe and allow the user to tighten down the probe when the tip is at the recommended insertion depth. Therefore, the user can select a probe that is longer than necessary if there is no clearance issue in doing so. Compression fittings are typically stainless steel, but the ferrule material can either be the

same material or Teflon®. The advantage of the Teflon® ferrules is that they will not swage onto the probe after tightening, allowing the probe to be repositioned or relocated at a later time.



The TA2's versatile transmitter head allows for up to 270-degree rotation.

Another advantage of insertion probes is the option to be "hot tapped." Using a retractable probe assembly, the user can remove the flow meter under process conditions to prevent shutting down the line. The assembly may include blowout prevention if there are safety concerns of the probe ejecting under higher pressures.

Knowing the flow direction during installation is also essential. Some manufacturers will request this information during the ordering process, but MAGNETROL calibrates with flow going from left to right as a standard and includes the flow arrow on the probe. If installing the probe with the flow going from left to right is not ideal for viewing and configuration, the user can rotate the transmitter housing by loosening the set screw at the base. There is also a stop screw in the back side to prevent over-rotation. Rotate the head up to 270° and then tighten the set screw back down. The backlit display is rotatable in 90° increments as well for easier viewing.

Ease of wiring further simplifies installation of the TA2. Thermal flow meters have a front and rear compartment. Wiring takes place in the rear compartment. The TA2 terminals come off of the board and the terminal descriptions are clearly marked. Selection of input voltage is not necessary as there are two separate terminals for VAC and VDC inputs that come standard with every model.

Calibration

All thermal mass flow meters must be calibrated to measure accurately. This involves a flow bench and running multiple flow rates past the sensor over the specific operating range. As a standard, MAGNETROL takes at least ten data points over the customer flow range. Oftentimes, the user will receive 15–30 data points which increases the accuracy of the curve. Depending on the needs of the application, the manufacturer may calibrate the unit with the actual gas it is going into or use some type of equivalency/correlation calibration. Some manufacturers have the capability of producing multiple calibrations to allow the flow meter to be accurate in two (or more) gases. It is a simple procedure to switch from one calibration curve to the next.

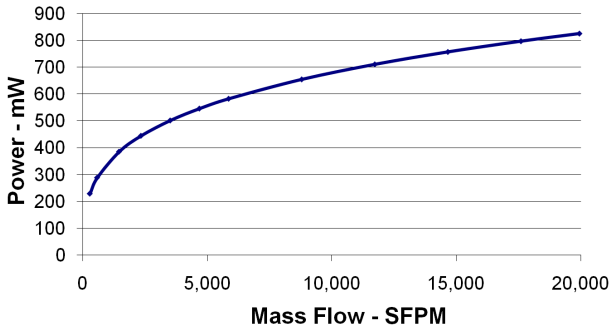
With the TA2, for any actual gas calibration the user will also receive an air calibration free of charge. For example, a unit that is currently calibrated for and measuring natural gas can be moved and installed into an air line. Another advantage is that the user can enable an equivalency mode in the unit to adjust that base air curve for other gases. A thermal flow meter will not measure accurately if it is being used in a gas for which it is not calibrated or configured to measure.

Depending on the manufacturer, there may also be ways of checking the calibration of the flow meter in the field or at the customer site. This saves time and money since the meter does not have to be sent back to the manufacturer. The TA2 has a calibration verification procedure that does not involve purchasing any external hardware to run the tests. It is not just a configuration check, but a true test of heat transfer.

Turndown

A flow meter's turndown is the ratio of the maximum flow divided by the minimum flow for which the meter is accurate. Thermal mass flow meters will typically specify a standard 100:1 turndown, although higher turndowns are possible with the additional data points previously discussed. This far surpasses differential pressure technologies that specify less than a 10:1 turndown. As shown in the example curve, thermal flow meters have high sensitivity

throughout the flow range, but particularly at low flows. The power curve is related to the sensitivity of the flow meter versus heat transfer. The heat transfer increases with the flow rate.



Relationship between power and mass flow rate.

Outputs/Communication

With today's thermal mass flow meter the user can select from multiple current outputs, alarm outputs, and pulse outputs. Two current outputs enable the user to measure flow rate as well as process temperature from one transmitter.

For communication protocols it is still very advantageous to have HART®. Using the HART® signal in conjunction with the specific product device type manager (DTM) allows the user to configure and run diagnostics from their laptop using PACT*ware*™ software. Both the DTM and PACT*ware*™ can be downloaded from the MAGNETROL website.

Many manufacturers are also offering a diverse range of additional communication protocols, including FOUNDATION fieldbus™ digital communications for an interconnected network.

Summary

The thermal mass flow market is one of the fastest growing flow meter segments. It will continue to rise due to environmental regulations as well as cost savings associated with energy management. Although the oil and gas industry is the primary driver, these flow meters can be found in many industrial, municipal, and commercial facilities. If you have a boiler, you may very well find a thermal flow meter not far away.

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