TSI® Mass Flowmeters—Theory of Operation

Application Note

TSI mass flowmeters utilize a thermal film sensor to measure gas flow. This thermal film sensor is a type of thermal anemometer. A thermal anemometer measures gas flow by sensing changes in heat transfer rate from a small, electrically heated sensor exposed to the gas under study. The heated sensor is held at a constant temperature using an electronic control circuit. The cooling effect resulting from the gas flowing past the sensor is compensated for by increasing the electrical power to the sensor. The magnitude of power required to keep the sensor at a constant temperature is proportional to the mass flow rate of the gas and inversely related to the temperature of the gas. A temperature sensor is mounted up stream of the flow sensor to measure the gas temperature. With these two signals a mass flow rate measurement can be calculated.

Thermal conductivity and viscosity of the gas also affect the amount of heat transfer from the sensor. Because of the multiple parameter effect, each gas or gas mixture has a unique calibration.

The flow signal is non-linear which allows for a percent of reading accuracy as opposed to most flow measurement technologies that give a percent of full-scale accuracy. Thermal anemometry flowmeters can be used to cover the same range that it would take three pressure-based flowmeters to cover. Most TSI flowmeters have a digital signal processor that linearizes the flow signal. TSI uses a high accuracy flow reference to calibrate the meter wide range of flow.

TSI's thermal film sensor is manufactured by sputtering a thin film of platinum on a small diameter rod. The rod gives the sensor more strength than a platinum wire, which is another similar type of thermal anemometer. The small mass of the film gives the sensor very fast response time. This fast response is ideal for closed-loop control systems and integrated volume measurements.

The film sensor is highly sensitive to low velocity flows, which allows for larger diameter flow tube. The larger diameter tuber results in lower pressure drop. Lower pressure drop reduces flow circuit backpressure and its effects.

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