Three Gas Flow Measurement Technologies

Below we describe three basic sensor principles for gas mass flow meters from about 1 mln/min up to around 2900 ln/min (gas dependend).

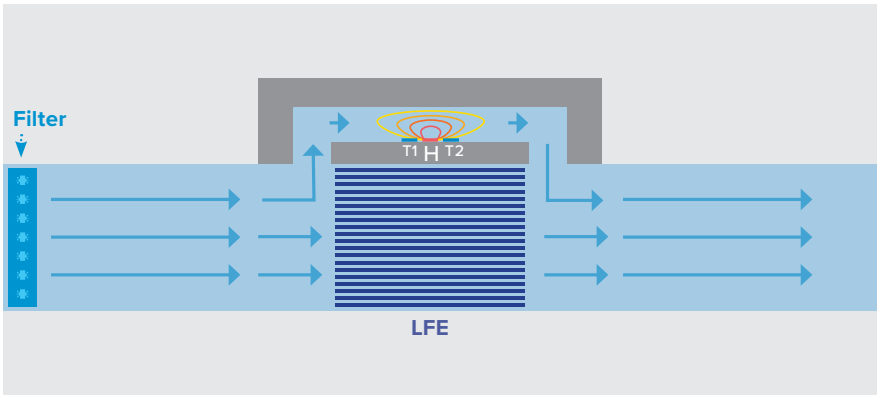
MEMS Sensor

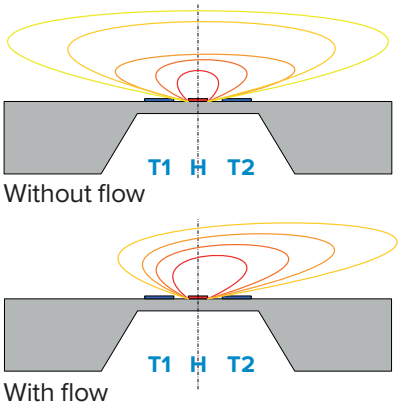
The MEMS gas flow sensor is based on the thermal measurement principle, basically you heat something up in the sensor and the gas that goes past that minute heater cools it off. The cooling effect is related to the gas mass flow. The MEMS (microelectromechanical systems) is basically a CMOS chip, in principle build up like any modern chip like f.i. a microprocessors.

The thermal flow measurement principle is available as different types of sensor like the capillary, immersible or MEMS and all offers a number of specific advantages. Most important, they all measure the gas mass flow. Important because gas is compressible, meaning that the volumetric measurement does not tell you a lot. The mass flow tells you how many gas molecules are in your flow and that is what counts when you have chemical or bio processes, flames reactions, respiration, etc. They have no moving parts and are, partly due to that, very reliable.

Specific advantages of the MEMS are the longterm stability, zero drift, small size and low energy requirement (we have MEMS flow units that work on a single AA standard battery). Measurement takes place directly in the medium, with a microheating element operated between two temperature sensors. If there is no gas flow, the temperature sensors T1 (upstream) and T2 (downstream) heat up equally. If gas flows passes the sensor, it cools T1 and, due to the additional heat dissipated by the heater, heats T2 simultaneously. The difference in temperture between T1 and T2 is an indication for the flow.

To achieve different ranges there is often a bypass avoid splitting system build in the flow meter, so that only a defined part of the flow goes past the sensor, the ration is fixed so if you know the sensor flow, you know the total flow.



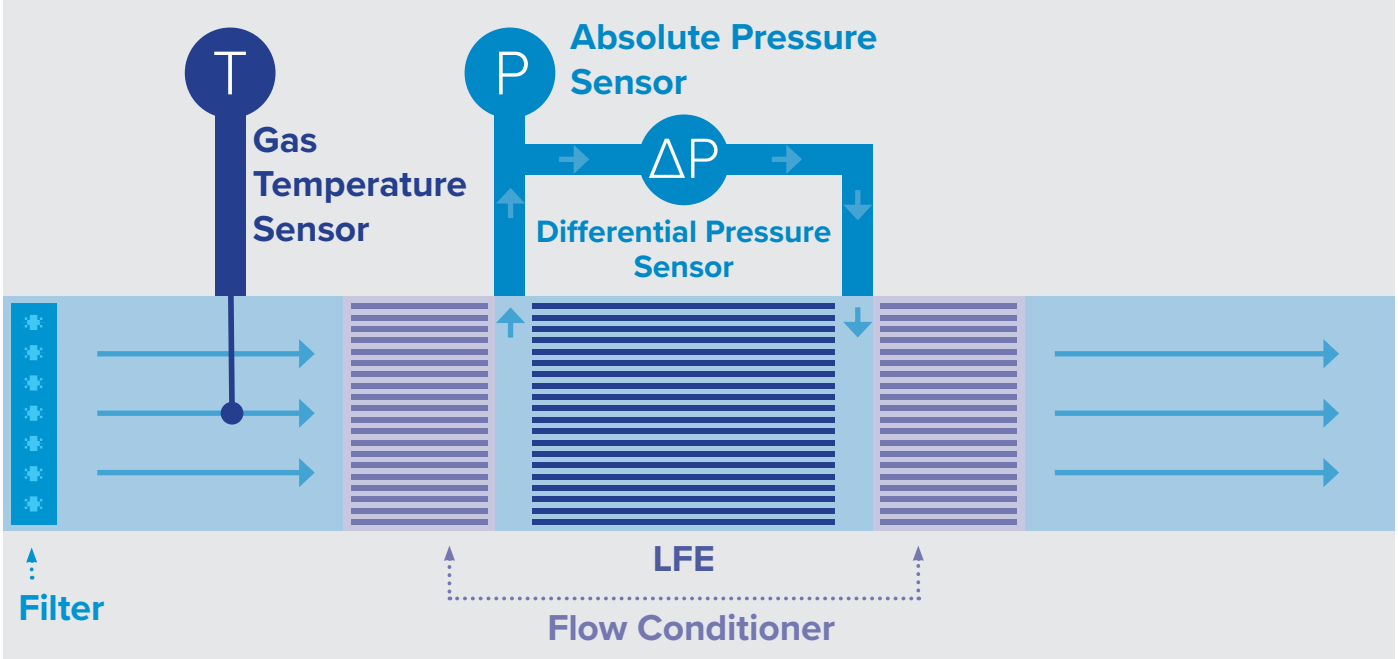


Differential Pressure

If you put a restriction in a pipe with gas flow, there will be a pressure drop over that restriction. In a differential flow meter, you measure the pressure drop over a restriction. If the mechanics are fixed you will get a bigger pressure drop at high flow and no pressure drop when there is no flow. If you make that restriction a bit special (laminar flow element) the relation between that flow and the pressure drop is linear. With that you can very accurately measure the volumetric flow. As mentioned with gas we are more interested in mass flow. The relation between volumetric flow and mass flow is for a specific gas defined by the pressure and the temperature of that gas. So, in a differential mass flow meter you find a differential pressure sensor, an absolute pressure and a temperature sensor. This all goes into a micro-processor that calculates, based on these three variables, the total mass flow going through that flow meter.

Because you have all these sensors, you have what you call a “Multi parameter flow meter”. So called because you can read the mass flow, volumetric flow, the pressure, temperature and you can calculate the density of the gas flowing through this flow meter.

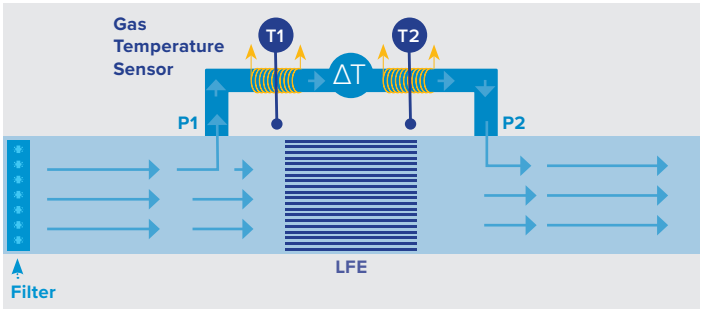
Most differential flow devices can measure all gases based on one calibration by air. Other advantages are that they can measure very low and high flows and are very accurate and flexible.



Capillary Sensor

The capillary thermal mass flow sensor is closely related to the MEMS, it also works on same cooling effect. The gas goes through a very small metal tube (0.1 to 0.9 mm). The heater and temperature sensors are very thin platinum wires wrapped around the small tube. They heat the tube up and just like with the MEMS there is an upstream and downstream sensor. When there is a flow going through the tube, the difference in temperature between these two coils, is measured by measuring the resistance of the platinum wires (So called PT elements). The electronics translate this difference in resistance in a flow indication.

The specific advantage of capillary sensor is that some can handle huge pressure (up to 700 bar), that they have nothing but metal wetted parts (for instance suitable for corrosive gases) and that there are fixed relations between different gasses, meaning you can calibrate them with air and with a factor make them suitable for any gas. Just like with the MEMS they use a bypass (Laminar flow element or LFE) to make one size sensor suitable for different ranges flow meters.



Controllers

Most of these meters can also be delivered with an integrated control valve. Instead of measuring the flow you can tell these units how much flow you want and they will automatically adjust the valve so you get the flow you want. These units are called “mass flow controllers”. The nice thing is that if anything changes in you process, these units will automatically adjust that valve so the gas mass flow stays accurately fixed.

The application of these units is endless, per year more than 7 million of these units are applied in all kind of processes and all kind of industries. If you need any support with the selection of the right flow meter for your application, do not hesitate to call us!