Some straight talk on field accuracy of flow meters

When talking about the accuracy of flow meters, it is important to have some basic knowledge about what influences it. We see a lot of discussions on platforms like LinkedIn, where people are making statements about accuracy without telling the true story. In this article, we will give you some practical answers to common questions.

Spot/ single point type flow meters

In some discussions about flow meters we see statements like: “with our flow meter, you only need 10 to 15 Diameters”. In fact, this is not possible on planet Earth, when measuring compressed air or gas with a spot measurement type, or “single point type” flow meter. It’s against basic Physics.

Now, what is considered a “spot measurement/ single point type” flow meter? These are all flow meters that calculate flow based on a velocity measurement in a single point in the pipe. An obvious example is the insertion flow meter, which is one of the most used flow meter types for audits. Another example, less obvious from the outside, is an ultrasonic clamp-on meter. This meter also measures the flow in one straight path. Some meters use more advanced technologies, like double path, or even multiple paths, but these are less commonly used in compressed air applications.

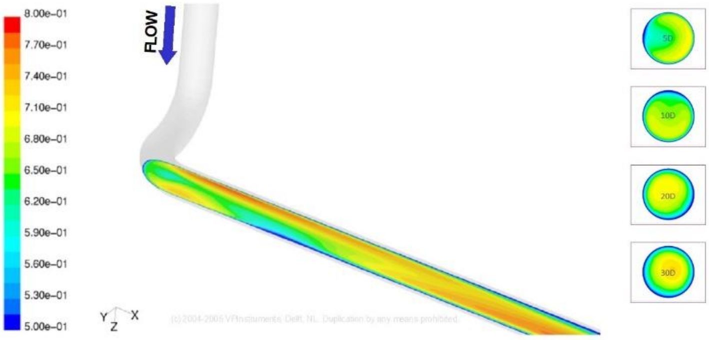
Field accuracy vs. specifications

In compressed air applications, even the most accurate flow meter can be misapplied, which may result in large systematic errors or random erratic readings. In compressed air flow audits, especially in old, existing compressed air systems, obtaining realistic measurement data can be a very tricky thing, as all “spot measurement type” flow meters are prone to up- and downstream disturbances. These disturbances are often causing large deviations.

The perfect installation spot in existing factories is often a challenge.

Examples of items that can disturb the flow profile are double elbows, abrupt diameter changes, and large T-pieces. In many cases, the customer can only place the flow meter 5 or 10 diameters downstream of these items, which will have a large influence on the field accuracy.

A flow meter is calibrated under ideal conditions, which means it will be subjected to a known, symmetric velocity profile in a reference pipe with known inner diameter. But when you have to install a flow meter in a pipe on a too short distance from potential disturbances we advise you to add at least 5% to 10% to your uncertainty budget and make sure all parties involved are aware of the additional measurement uncertainty. Especially when “testing” compressor performance in the field, one needs to be very careful.



Turbulent vs. Laminar

We still hear people talking about “laminar flow” in compressed air. Let’s get this straightened out as well. Did you know that compressed air, due to the high velocities and large pipes, is always turbulent? In compressed air networks, you will never reach laminar flow unless you are measuring very low velocities. Why? Because of another law of Physics, which is described by Reynolds and others. But don’t worry, it is not a problem at all. It actually has an advantage, as the flow profile is rather flat instead of parabolic. Which makes insertion of your flow meter less critical in larger pipes.

From now on, we should talk “fully developed” flow, instead of laminar, which means the flow profile is nicely symmetric, equally distributed over the pipe surface. It will take quite some length to become symmetric, in some cases, especially with double elbows out of plane, we have seen that it takes up to 60 D.

Flow meter technologies compared – things to be aware of

Thermal insertion probes: flow profile effects and temperature effects. Sudden changes in temperature can influence the measurement. Water drops will give spikes in the measurement signal.

Differential pressure probes: flow profile, turndown ratio is limited, be aware of low flow. Water drops and dirt might clog pressure ports. Water in connecting pipework can give strange results.

Ultrasound: Flow profile, ultrasonic noise from valves, vibration, signal loss.

Vortex (in-line): Water drops, turndown ratio is limited, be aware of low flow and permanent pressure loss over the meter

Differential pressure (in line): Limited turndown, be aware of low flow. Permanent pressure loss when using orifice type meters.

Turbines: Oscillation can give higher or lower average flow values. Pressure pulses might damage the bearings. Water can cause corrosion, causing misreadings.

How accurate do you need to be?

In an audit, it depends on what you are looking for (leaks, demand profile, compressor control system performance, compressor efficiency). When analyzing the data, it is all about the auditor skills, and how the auditor interprets the combination between various sensors and signals.

Sometimes, a simple load/unload signal of a compressor can already provide insight in the control system behavior, in other cases you might want to zoom into the demand side, where you need a bi-directional flow meter. The more signals you combine, the more clarity you will get about what is going on exactly.

In general, 5% accuracy is fine for an air audit using insertion probes, taken all uncertainties into account. If you want to test a compressor in the field, and compare it to factory specs, you must check the ISO 1217 directive on the required accuracy. This might require special equipment and specialized people to carry out the test.

Need some advice?

Contact us to discuss your application. We will be happy to advise you with selecting the right product, which might not be a flow meter in some cases.