Flow testing with Method Q: what it is good for – and when a Pitot tube belongs in the set-up

innomatec Practical Know-how | October 2026

In most leak tests, the question is: Is the part tight? In flow testing, we turn it around: How much air gets through? That sounds like a small difference. In practice, it is a discipline of its own with its own pitfalls. The biggest of these has surprisingly little to do with the instrument and a lot to do with the question of **where** the pressure is measured.

In this article, we explain how Method Q works, which tasks we use it for, why it is sometimes preferable to a pressure decay test, and how to tell whether a Pitot tube is needed.

In brief

Method Q: The test pressure is held constant while a mass flow meter measures the air flowing in. The result is shown directly in ml/min or l/min.

Typical applications: Nozzles, bores, filters, valves, membranes and leak tests with larger leak rates.

Pitot tube: It measures the pressure directly in front of the test part instead of inside the instrument. Rule of thumb: required at a test pressure below 300 mbar AND a flow above 10 l/min.

The principle: hold the pressure, measure the make-up flow

At innomatec, this method is called **Method Q**, after the symbol for volume flow. The instruments for it carry the Q in their name, for example the LTC-802Q. The principle fits into one sentence: **We keep the pressure in the test part constant and measure how much air has to flow in to keep it that way.**

A precision pressure regulator builds up the test pressure and holds it. Between the regulator and the test part sits a mass flow meter – depending on the measuring range, a thermal sensor or a laminar flow element. Whatever escapes through the test part, whether through a nozzle, a bore or a leak, has to be replenished via the flow meter. Once everything has settled, the rule is: what goes out at the back comes in at the front. That is exactly the amount the instrument displays.

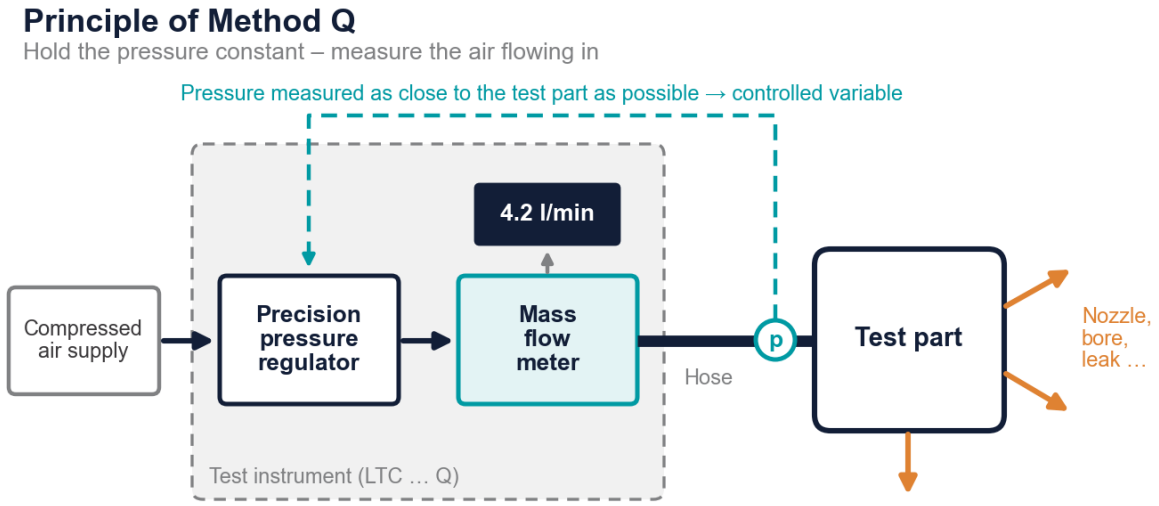


Figure 1: Set-up of Method Q – the pressure at the test part is the controlled variable, the flow is the measurement result

If you would like a picture: think of a garden hose with a water meter. The water pressure is fixed, and the meter shows how much flows through the spray nozzle. If the nozzle is half blocked, less flows through, and the meter notices immediately.

The test sequence is the same for all Q instruments:

- **Fill:** The test part is brought up to test pressure.
- **Stabilize:** Pressure and flow stabilize, filling effects die away.
- **Measure:** The pressure is held constant, and the make-up flow is recorded and evaluated.
- **Vent:** The test part is depressurized and released.

The measuring range is enormous. With suitable sensors, values range from about 1 ml/h (around 0.016 ml/min) up to about 1,000 l/min. The upper limit is really only set by the valve and line cross-sections that still fit into the instrument.

What Method Q is used for

In our projects, we come across two families of tasks.

1. Flow-through and function testing

Here, parts are supposed to let air through – in a defined quantity. **Too little** flow is the defect: a forgotten bore, a burr in the nozzle, chips in the channel, a clogged filter. Often, **too much** flow is a defect as well, for example when a membrane is missing or a filter fleece is damaged.

2. Leak testing with larger leak rates

With large leak rates, the pressure in a pressure decay test collapses so quickly that a leak can hardly be measured meaningfully any more. Method Q, by contrast, keeps the pressure constant and delivers the leak rate directly and at the right pressure level.

Application	Typical question	What a deviation means
Nozzle, orifice, restrictor	Is the effective cross-section correct?	Too low: burr, contamination, dimensional error
Bore, channel	Is the bore present and clear?	No flow: bore missing or blocked
Filter, screen	Is the permeability within the target range?	Too low: clogged · too high: damaged or missing
Valve	Does it open as intended?	Sticking, wrong spring, wear
Membrane, pressure compensation element	Can the housing “breathe”?	Too low: stuck · too high: membrane missing
Leak tightness with large leak rate	Is the leak rate below the limit?	Too high: part is leaking

Why measure flow and not simply pressure decay?

The pressure decay test is and remains the most widely used method. However, Method Q has strengths that make it unbeatable for certain tasks:

- **The result is the quantity you are looking for.** The value is shown in ml/min or l/min, i.e. in the unit that usually appears on the drawing as well. There is no need to convert via the test part volume.

- **It is fast.** Depending on the part, cycle times under two seconds are possible.
- **It works with open parts.** You cannot test a nozzle by pressure decay – after all, it is supposed to let air through.
- **It copes with large leak rates.** Where the pressure collapses immediately in the pressure decay method, Method Q measures stably.

There is one catch, however, and it is crucial for the rest of this article: **The flow depends on the pressure.** Through a nozzle, the flow increases roughly with the square root of the pressure difference; through a fine capillary, it is even approximately proportional. So if the pressure at the test part is 5 % too low, you measure about 2.5 to 5 % too little flow, depending on the geometry – without the instrument reporting any error.

Anyone who wants to measure flow accurately must therefore first capture the pressure correctly – where it acts: at the test part.

The underestimated error: where is the pressure measured?

Flowing air loses pressure

In a pressure decay test, the air is at rest. In a static system, the pressure is the same everywhere, in the instrument just as in the test part. Where the sensor sits then hardly matters.

With Method Q, however, the air flows continuously, and any flowing air loses pressure through friction at the hose wall. The higher the flow, and the longer and thinner the hose, the greater the loss. If the instrument measures the pressure internally, it dutifully controls to the set point – but inside the instrument. Less arrives at the test part.

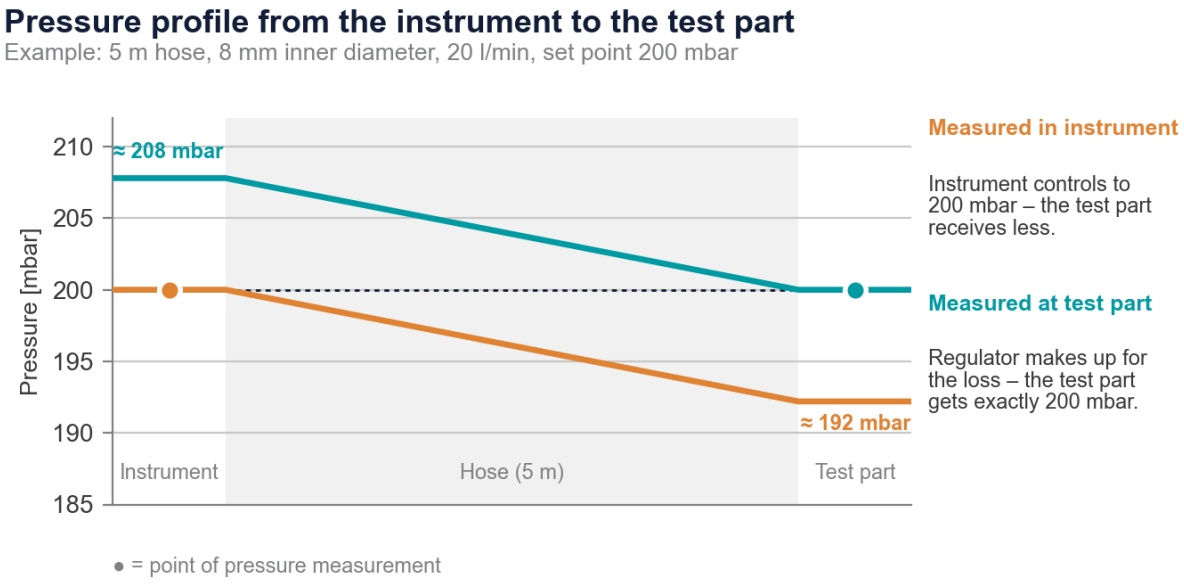


Figure 2: Without an external measuring point, about 8 mbar are missing at the test part in this example – yet the display still shows 200 mbar

In the example above, almost 4 % of the test pressure is missing at the test part. The tricky part: the display shows 200 mbar, and the measurement appears stable and repeatable. Only when comparing with another system or a different hose does it become apparent that the values do not match.

Static and dynamic pressure

The second effect is somewhat more subtle. Hold your hand out of the window while driving: the faster you go, the harder the air presses against your palm. That is the **dynamic pressure** (velocity pressure). It acts only in the direction of flow and grows with the square of the velocity. The **static pressure**, on the other hand, acts equally in all directions. Together, they make up the **total pressure**.

For the measurement, this means: a side tap, as on a simple T-piece, sees a different pressure – depending on flow and geometry – than an opening that faces directly into the flow. At low velocities the difference is negligible; at high velocities it is not.

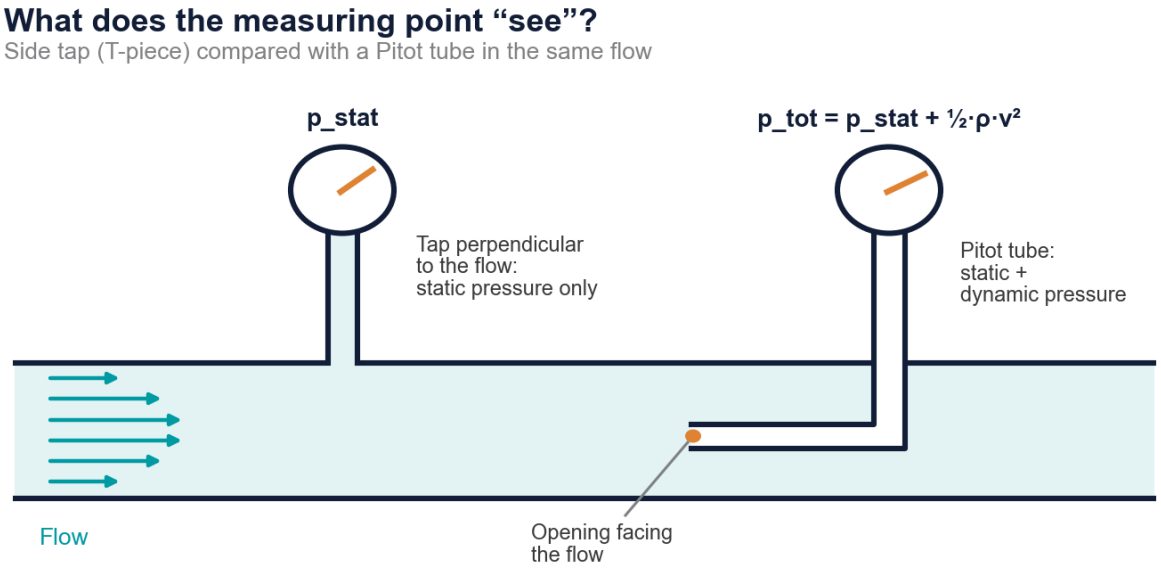


Figure 3: A side tap and a Pitot tube measure different pressures in the same flow

We measured how large this gets in practice. Using G1/2" connections, we compared three variants of the measuring point at flows from 50 to 350 l/min: a Pitot tube, a DIN measuring tube and a simple T-piece.

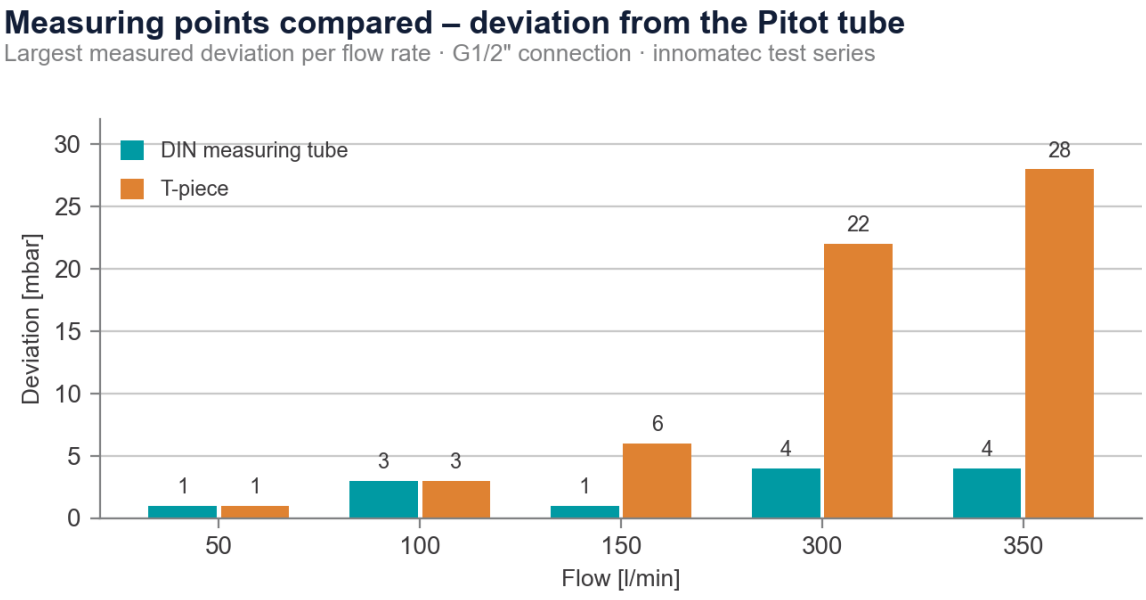


Figure 4: Up to 150 l/min, all three variants are close together. Above that, the T-piece deviates significantly

Up to about 150 l/min, the measuring points differ by only a few mbar. At 300 and 350 l/min, however, the T-piece reads 22 and 28 mbar higher than the Pitot tube. At a test pressure of around 660 mbar, that is a good 4 %. The DIN measuring tube stays within 4 mbar even there. Incidentally, from 300 l/min upwards we had to switch to a pressure regulator with a G1/2" connection – otherwise the flow could not be reached at all.

The Pitot tube: an old trick with a big effect

The Pitot tube is almost 300 years old. The French engineer Henri Pitot developed it in 1732, when he was asked to measure the flow of the Seine. Today it is fitted to every aircraft, where it provides the airspeed. The principle is simple: a bent tube points its opening against the flow. The air stagnates there, and the total pressure builds up inside the tube.

In flow testing, we do not use the Pitot tube to determine a velocity. We use it to pick up the pressure cleanly **directly in front of the test part**. The trick: no air flows through the measuring line from the Pitot tube to the pressure sensor in the instrument. Without flow there is no friction loss, so the sensor sees exactly the pressure that is present at the test part. The pressure regulator then controls to this value and automatically compensates for the loss in the supply hose.

There are two practical consequences you should know about. First, the Pitot tube sits outside the test instrument, as close as possible to the test part. Second, the connection for the test leak must also be **downstream of** the Pitot tube. The standard test leak port on the front of the instrument is then usually no longer the right place.

When do you need a Pitot tube?

The rule of thumb

For years, our internal guideline has contained a simple rule that has proven itself:

> **Use a Pitot tube if both conditions are met:**
> Test pressure **below 300 mbar** AND flow **above 10 l/min**.
> If the test pressure is above 300 mbar or the flow is below 10 l/min, you can generally do without one.

Why these particular limits? At higher test pressures, the pressure loss in the hose is small relative to the test pressure. At low flows, the air moves so slowly that friction and dynamic pressure hardly matter. It only becomes critical when a lot of air flows at low pressure.

Two special cases: with **vacuum**, the usable pressure differential is limited from the outset, and every loss in the line has a direct effect. Here, we always coordinate the application with our measurement engineering team and usually use a Pitot tube. At **very low test pressures** of about 10 to 100 mbar, the pressure must always be measured very close to the test part.

A closer look: pressure loss in the hose

The rule of thumb covers most cases. For long or thin supply lines, however, we do the maths. Behind it is the classic Darcy-Weisbach pipe friction calculation, split into laminar and turbulent flow. The loss is evaluated as a percentage of the test pressure:

- **up to 2 %:** usually no Pitot tube required, as this is within the tolerance of the test pressure
- **2 to 20 %:** use a Pitot tube or choose a larger hose
- **above 20 %:** no meaningful measurement is possible with this hose

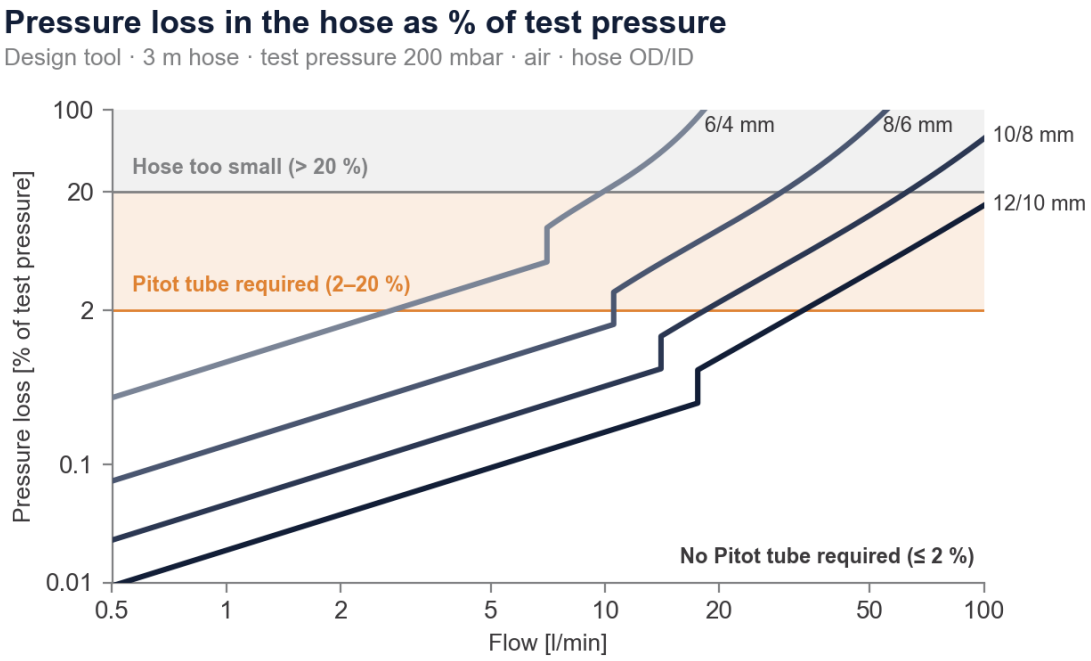


Figure 5: Pressure loss as a function of flow and hose size. The step marks the transition from laminar to turbulent flow

The step in each curve stands out. At this point, the flow changes from laminar to turbulent, and from then on the pressure loss rises much more steeply. The influence of the diameter is just as clear: halving the inner diameter increases the pressure loss roughly 16- to 28-fold. Hose length, by contrast, only has a linear effect.

A practical example: 20 m supply line, 4 l/min, 200 mbar test pressure. With a 6/4 mm hose you lose just under 22 % of the test pressure – a meaningful measurement is not possible. With 8/6 mm it is just under 4 %, so a Pitot tube is needed. With 10/8 mm it is only 1.2 %, and the Pitot tube is unnecessary. **Sometimes the larger hose is the simpler solution.**

Practical tips from commissioning

- **Keep hoses as short as possible and as wide as sensible.** The diameter has a much stronger effect than the length.
- **The narrowest component counts.** Push-in fittings, couplings and adapters often have a smaller cross-section than the hose. A 10/8 mm hose with a 4 mm push-in fitting behaves like a thin hose at that point.
- **Measuring point close to the test part.** With or without a Pitot tube: the closer, the better.
- **Test leak downstream of the measuring point.** Otherwise, you calibrate a different set-up from the one used in production.
- **For large flows, remember the regulator, too.** It must also be able to deliver the mass flow precisely.
- **Mind the standard volume.** Mass flow meters display the flow referred to standard conditions (e.g. Nml/min). When comparing with values from drawings or data sheets, check which conditions they refer to.
- **Cross-check regularly.** A test leak or a calibration device such as the DF-10 quickly shows whether the entire measuring chain is still correct, not just the instrument.

Conclusion

Method Q is one of the most direct test methods there is: hold the pressure, read the flow, done. It is fast, delivers the result in the unit shown on the drawing, and works even where other methods reach their limits. Its accuracy, however, stands or falls with the pressure at the test part. As long as little air flows at a decent pressure, measuring inside the instrument is sufficient. If a lot of air flows at low pressure, the measuring point belongs at the test part – and the Pitot tube is the proven tool for that.

If you are unsure whether your application needs a Pitot tube, send us the test pressure, flow and hose length. We will be happy to do the calculation for you.

Sources and further reading

- innomatec: Leak testing seminar documents
- ISO 3966:2025 – Measurement of fluid flow in closed conduits – Velocity area method using Pitot static tubes
- DIN EN 1779:1999 – Non-destructive testing – Leak testing – Criteria for method and technique selection
- Encyclopaedia Britannica: Henri Pitot; Wikipedia: Pitot tube (history and measuring principle)