# Precise Steam Metering

## The precise measurement of steam is becoming ever more important

Steam is a heat carrier and therefore a key medium frequently used by energy companies. The devolution and decentralization of companies has led to an increasing demand for reliable methods for measuring steam. And seeing as the producer and consumer are not one and the same, precise meters are required at the relevant interfaces. The choice of the measuring method can play a significant role in influencing the final costs.

Steam measurements cannot be calibrated – a fact that is clearly defined in the calibration regulations. This is obviously a problem for both the producer and purchaser of steam. Naturally, both sides desire a precise, reliable and comprehensible measuring system since even the smallest measuring uncertainty can become extremely expensive when large volumes of steam are required. However, only a few methods are suitable. The most important are traditional pressure differential metering in accordance with ISO 5167, vortex meters and dynamic probe measuring.

### Standardized: Pressure differential measurement

A steam billing measurement must meet the following criteria for a supplier or purchaser of steam:

- small measuring uncertainties with large measuring dynamics
- large confidence range and high availability

**Steam measurement cost calculation**

Presumption

| | | |
|---|---|---|
| Steam mass flow rate / hour | = | 80 t/h |
| Steam price / barrel | = | 25 €/t |
| Operating period / year | = | 7,200 h/a |

Billed amount / year

80 t/h x 7,200 h/a x 25 €/t = 14.4 Mio. €

Steam measurement uncertainties and the resulting costs in Euros

Measuring uncertainty ± 5% > ± 720,000 Euro/a

Measuring uncertainty ± 3% > ± 432,000 Euro/a

Measuring uncertainty ± 2% > ± 288,000 Euro/a

Measuring uncertainty ± 1% > ± 144,000 Euro/a

Measuring uncertainty ± 0,5% > ± 72,000 Euro/a

**Conclusion: steam measurement uncertainties can quickly become expensive**

- Verifiability on site, plausibility check
- Legal certainty and / or traceability to international standards of measurement

The requirements can only be met with standardized pressure differential devices and harmonized equipment technology. Apart from where a few minor amendments have been required, the pressure differential device standard ISO 5167 is valid worldwide. No other measuring method has been examined to such a degree, tis performance has also been confirmed by conducting calibrations at various test benches. The popular opinion that pressure differential metering is only possible with low measuring dynamics and high measuring uncertainties is no longer valid. Even in traditional pressure differential measurements, modern equipment technology allows measuring ranges of up to 50:1 with a measuring uncertainty of 0.5 % of the measured value in terms of the mass flow rate and energy flow.

However, the individual components and the test method of a pressure differential measurement chain must satisfy extensive requirements; from selection of the pressure differential device and the transducer – pressure differential, absolute pressure, temperature – to the steam flow or steam energy calculation unit. Correct evaluation and consideration of the inlet and outlet situation as well as the steam status are always essential for the correct design.

A decisive advantage of this method is that a current steam measurement can be verified. When selecting the pressure differential device in terms of its application, the wear and tear of measurement relevant parts over the years is not something which has to be considered. The respective transducer can be checked on site.

### Suitable for pipe diameters of up to 300 mm: vortex meter

Vortex meter technology is also suitable. The direct linear correlation between vortex separation and flow velocity in a specific range enables comparatively simple further processing of the signals. A measuring system consists of the vortex meter, the pressure and temperature transmitter and a flow or energy calculation unit. The application range is ideal for temperatures ≤ 300°C and nominal sizes ≤ DN300. However, further measures are required for a steam billing measurement. As with the previously described pressure differential measurement, the inlet and outlet sections are necessary as an integral part of the overall measurement. The vortex meter and the inlet and outlet section create a permanent unit. A pressure and temperature measuring unit is integrated into the measuring section.

**Steam measurement offsetting with venturi tube according to DIN EN ISO 5167**
**METRA Energie-Messtechnik Speyer**
**Medium: steam, mass flow 65 t/h, steam pressure 21 bar(abs), steam temperature 280 °C**

Manufacturer specifications are available for the required inlet and outlet sections. Generally applicable inspections or even standards, as used for the pressure differential measurement, are not available. The international standard ISO 5167 should be used as guidance when determining the necessary installation lengths. Factory calibration of the individual components is definitely insufficient. The entire measuring system, consisting of the vortex meter measuring section, pressure and temperature measuring unit as well as the flow and energy calculation unit, must be tested under close-to-reality conditions at a suitable accredited test bench that mirrors the later working environment. The same applies as for the pressure differential measurement. Only the testing and interaction of the entire measurement chain enable a reliable statement about the expected measuring uncertainty. Operating conditions which cannot be covered by the calibration, for example high medium temperatures, must be considered in a theoretical approach.


**Universal flow and energy computer ERW 700**
**(EC-Type Examination Certificate DE-08-MI004-PTB004)**
**METRA Energie-Messtechnik, Speyer**

## Dynamic probe: only suitable to a limited extent

Dynamic probe measuring is one of a number of pressure differential measurements. The flow-proportional pressure differential is detected via pressure vents in the probe and further processed as a flow rate and energy flow with the aid of pressure and temperature in combination with a calculation unit just the same as for traditional pressure differential measurement. Installation of the dynamic probe is quite simple, as it is inserted into the pipe via a borehole. However this does have certain disadvantages: manufacturing tolerances, surface quality, eccentricity as well as the manufacturing method of the pipe are not taken into consideration. The much acclaimed low loss of pressure is achieved at the price of a very small pressure differential signal and thus less measuring dynamics. Doubts have also been expressed with regard to the very short inlet sections demanded by many manufacturers for a pressure differential method. Faults or imbalances in the flow profile are not or only partially detected by the probe.

## Conclusion

Traditional pressure differential measurements in accordance with ISO 5167 are best suited for steam billing measurements. This method should be favored if there is sufficient space, and it is still the only method which is traceable to international standards of measurement. The large confidence range and the possible on-site plausibility check provide the operator with the required level of reliability. The vortex meter method is suitable for certain areas of application. It is important that the complete measurement chain is considered and tested as a unit. Dynamic probe measuring is only partially suited as a billing meter.

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# Reliable interface

## Compressed Air: Basis for cooperation

**In industry, compressed air is one of the most used but also most expensive energy carriers. To keep costs down and transparent, an increasing number of companies employ service providers to operate and maintain their compressed air systems. Excellent cooperation is based on measuring devices which determine the quantity of compressed air reliably and are highly suited to rough industrial environments.**

Compressed air is required in almost all industrial plants. However, the provision of this versatile energy carrier requires a lot of energy and is therefore expensive.
In order to achieve efficient compressed air systems, an increasing number of energy service providers are now responsible for the operation and maintenance of systems, providing industrial companies with bespoke compressed air. Meters for compressed air required at the interface between the energy service provider and the industrial company to ensure correct billing of the supplied compressed air – a measuring system which both partners can rely on is necessary. To achieve this goal, METRA Energie-Messtechnik has drawn on its extensive experience in the field of flow and heat meters to develop the EVZ 100 meter for compressed air.

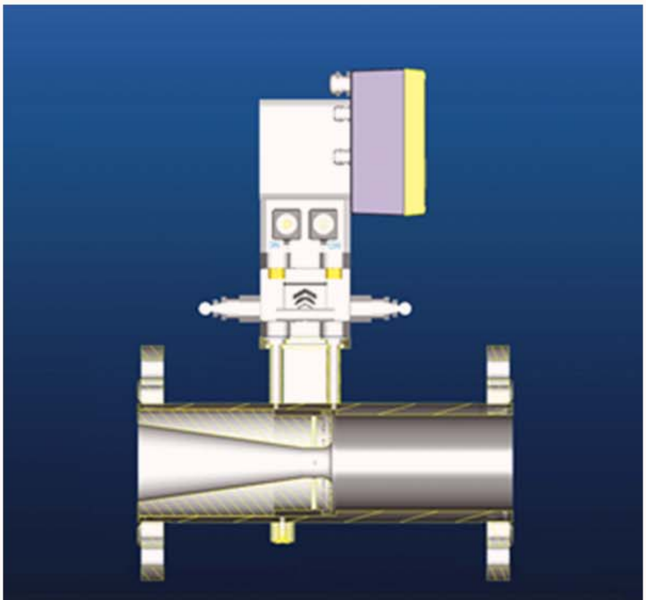
### Unique zero-balancing

The measuring principle of the EDZ 147 is based on traditional pressure differential metering.
A venturi tube has been selected as the pressure differential device, which is also defined by the international standard ISO 5167. Furthermore, the correlation between the volume flow rate and the differential pressure that equates to a large dynamic range and a simultaneous low loss of pressure of around 10 – 15 % of the applied pressure differential. The selected diameter ratio of the tube ensures that only small inlet sections are needed to achieve a precise measurement. The transformation of pressure differential into a signal proportional to the volume flow is realized in a pressure differential device with hydraulic zero balancing.

Hydraulic zero-balancing is a special feature of pressure differential metering. A hydraulic short circuit is generated automatically and at flow-dependent intervals via the ceramic pressure differential transducer. This zero-balancing compensates all disturbance variables that influence the zero point, e.g. aging, temperature changes and changes in static pressure. The measuring system can measure even the smallest pressure differential ranges precisely.

### Flow calculation unit included

Mass flow and standard volume flow are calculated in the directly-mounted flow calculation unit. This is where all the changing parameters, e.g. flow rate coefficient, expansion number, medium density and medium temperature-dependent geometric changes to the nozzle, are constantly calculated in real time and incorporated in the volume flow rate calculation.



Querschnitt des Druckluftzählers EDZ 147 mit Venturidüse

It is these properties of the METRA meter for compressed air which ensure dynamic ranges of up to 30:1 in relation to the mass or standard volume flow rate with measuring uncertainty of ± 1 % of the current measured value. The measuring uncertainty can be additionally reduced through calibration at an accredited gas test bench. All the calculated values, e.g. current values, measured values or error status, are output at a multifunctional display. The meter is also equipped with a current output and contact outputs. Therefore the EDZ 147 is ideally suited for billing or accounting measurements. For example Daimler established this meter in the factory in Sindelfingen as a balancing meter for compressed air.

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