NEW RESEARCH AND DEVELOPMENT CAPABILITIES

When compressed-air and natural-gas test rig are at one

Testing cannot guarantee quality. Quality has to be produced. But the quality of gas meters can only be proved by means of test rigs. Over 90 % of all turbine gas meters are calibrated only on air test rigs at atmospheric pressure even though they are operated at far higher pressures with natural gas when used subsequently.

The systematic characteristics of the measuring units are optimised to produce only a slight difference in practice between the air error curve in the region of low **Reynolds numbers**[1)] and the error behaviour when operating with high-pressure gas in the region of high Reynolds numbers. On a statistical average, this offset is very slight. It may fluctuate within a bandwidth of +/-0.5% in individual cases. However, it is characteristic that the high-pressure error curve is far shallower than the low-pressure error curve. A gas meter is considered to be "OK" if its error behaviour is very constant as a function of the Reynolds number or, even better, if its error behaviour is around "zero".

Basically, it is possible to comply with closer error limits for high pressure than is the case with low pressure. However, reliable individual statements on the error behaviour of turbine gas meters at higher pressures can be made only on the basis of tests under operating conditions on high-pressure test rigs with correspondingly high Reynolds numbers. Most high-pressure test rigs are operated with natural gas as the test medium but some also use air. However, on the basis of corroborated findings, it does not matter whether air or natural gas is used for testing. The only crucial factor is the Reynolds number at which the indicating error is established.

Fig. 1: The new high-pressure test rig at Elster-Instromet in Mainz-Kastel, Germany

*1) The **Reynolds number** is a characteristic fluid-dynamics parameter calculated from viscosity, specific gravity and velocity. The fluid-dynamics similarity theory states that flows, such as flows when testing cars in wind tunnel, behave in a similar fashion if they occur at the same Reynolds number. Applied to flow meters, this means that, if the Reynolds number is the same, the resultant measuring behaviour will also be the same over a broad measuring range. Consequently, it is extremely practical to determine the measurement error as a function of the Reynolds number.*

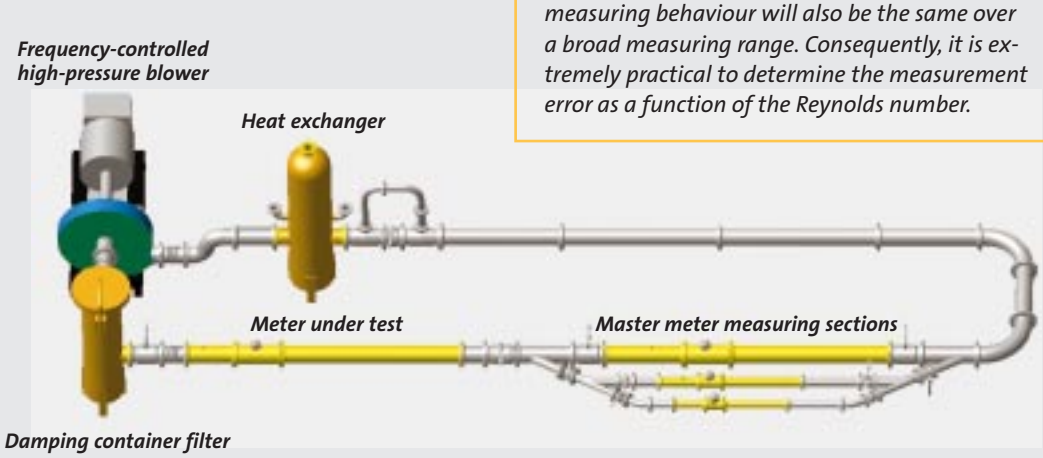


Fig. 2: The most important components of the test rig

Fig. 3: Comparison measurement on Elster-Instromet HP test rig and "pigsar" at 24 bar Measuring cartridge of the reference meter: TRZ-IFS DN 150

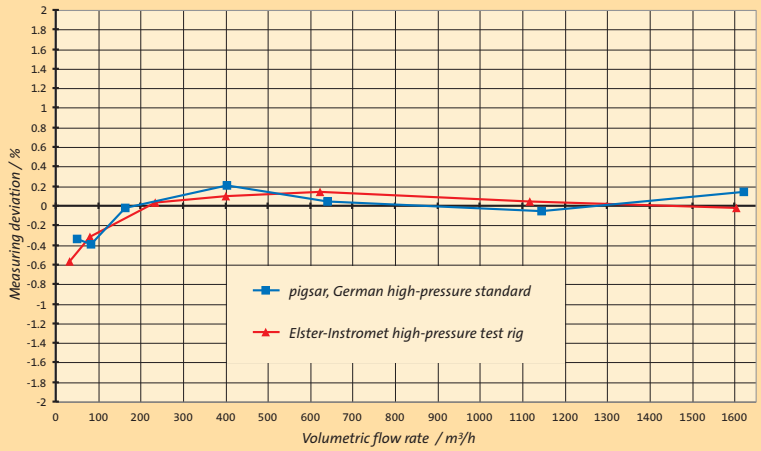


Fig. 4: Comparison measurement on Elster-Instromet HP test rig and "pigsar" at 20 bar Measuring cartridge of the reference meter: TRZ2 DN 100

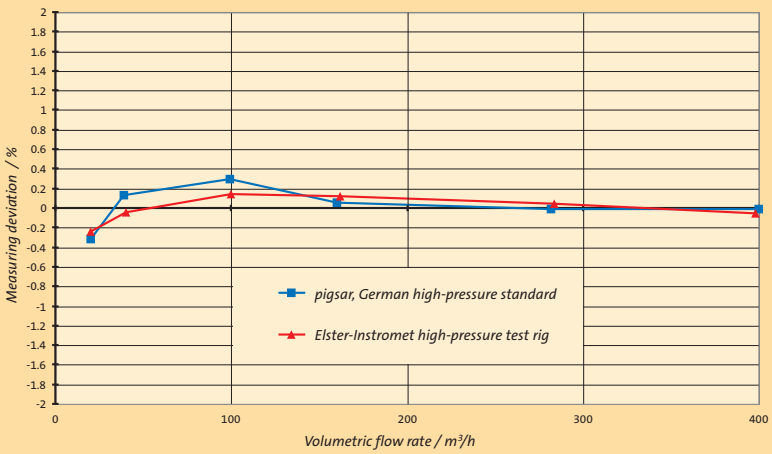
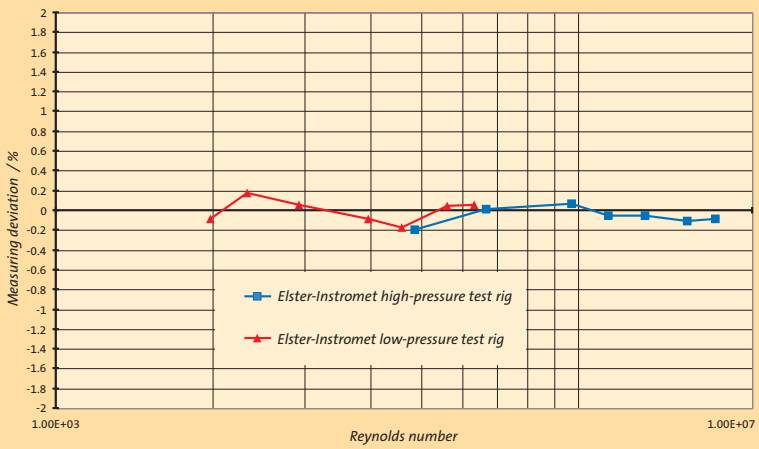


Fig. 5: Comparison measurement on Elster-Instromet LP and HP test rig Test pressure: air at atmospheric pressure and air at 23 bar Measuring cartridge of the reference meter: TRZ2 DN 100



Elster-Instromet has operated its own natural-gas test rigs in Germany and in the Netherlands for many decades now. For practical reasons, a decision was taken to install a new, air-operated, high-pressure test rig at the Mainz-Kastel production site:

- Air as the test medium is available with no problems
- No seasonal restrictions in flow rate
- Option for testing directly at the production site
- No long transport routes
- High flexibility when testing
- Test facilities available at short notice

The official calibration authorities granted the operating license for this new test rig, see Fig. 1, in April this year following a calibration procedure lasting several months.

The technical concept of this system has already been described in the "Profiles 2005, Vol. 2" customer magazine. The test rig is operated as a closed pipe circuit with compressed air.

The most important technical data of the new system is recapitulated below:

- Test pressure: 0 to 25 bar
- Units under test: turbine gas meters DN 50 – 200
- Pressure ratings: PN 10 to ANSI 600
- Flow measuring range: 5 to 1600 m³/h

The following components are crucial to functionality:

- Three parallel master meter paths, featuring two turbine gas meters of Series TRZ and a rotary gas meter of Series IRM-1 DUO as master meters
- One path for the units under test with various nominal diameters
- High-pressure blower, power output: 100 kW
- Heat exchanger for test medium recooling and stabilisation
- Filter and damping tank
- Pressure and temperature measurement
- Computer for control and evaluation (see Fig. 2)

The following criteria are important in respect of an assessment of the quality of such a test rig:

- Flow stability
- Pressure stability
- Temperature stability
- Quality of inflow to the master meters and to the unit under test
- Error reproducibility of the master meter
- Traceability of calibration of the master meter to fundamental standards

If these characteristics are reliably provided, it can be expected that the test rig will be highly precise, which can be verified by a low physical measure-

ment uncertainty. Final fine calibration procedures are currently still underway before it will be possible to state definitive values of measurement uncertainty (Fig. 6).

All master meters have been calibrated on the "pigsar" test rig, the "National Standard of the Federal Republic of Germany for High Pressure Natural Gas". The errors of the master meters are configured as multi-dimensional polynomials as a function of the Reynolds number in the computer for compensation. The PTB Test regulations (Volume 30) stipulate all fundamental requirements applicable to set-up and operation of high-pressure test rigs.

Comparison measurements on units tested on the "pigsar" test rig and on the new Elster-Instromet high-pressure test rig indicated an excellent level of concurrence, as shown by Figures 3 and 4.

Figure 5 shows the error behaviour of the TRZ2 measuring cartridge, an error behaviour that has hardly any improvement potential, as a function of the Reynolds number. The error values were measured on our air-operated low-pressure test rig at low Reynolds numbers. In turn, they were measured on the new air high-pressure test rig at high Reynolds numbers. There is a very good level of concurrence, particularly in the overlap region of the Reynolds numbers.

Fully automatic control of test sequence

Master meter paths for high flow rates

Fig. 6: Concluding work for fine calibration

PTB Directive G13 has, for some time now, demanded high-pressure calibration of operating pressures exceeding 4 bar. Our new test rig allows for the increasing demand for precise, reliable testing. It allows waiting times to be reduced while still providing a highly accurate measurement. Moreover, it also offers excellent research and development capabilities.

Please do not hesitate to contact us to arrange a visit to our premises and find out more about this product as well as our, or should we say your, new capabilities.

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