



A METHOD FOR MAINTAINING ACCURACY OF ULTRASONIC GAS FLOW METERS CALIBRATED ON AIR AT ATMOSPHERIC PRESSURE WHEN MEASURING NATURAL GAS AT HIGH PRESSURE





We are a Swiss company devoted to design, engineering and manufacture of flow metering solutions and related products based on the ultrasonic technology.



Our Goal



We strive to provide state-of-the-art, cost effective turnkey technical solutions to our valued clients throughout the world for fluid measurement and monitoring in related fields across a wide range of industries and applications.



We Design and Manufacture the Full Range of Solutions for Gas Measuring

- Domestic Gas Meters (G1,6...G6)
- Gas Meters for Housings & Public Utilities (G10...G650)
- Multichannel Ultrasonic Gas Flow Meters (G100...G 25 000)
- Reference Rotary & Turbine Meters (G2,5...G16, G100...G10 000)
- Calibration & Proving Rigs (Air/Natural Gas, G100...G2 500)
- Measuring Skids



The major issues of metrological support of ultrasonic gas meters are the following:

1. Adequacy of calibration and verification of ultrasonic gas meters using "air" at atmospheric pressure as medium as compared to the use of "natural gas" at working pressure as medium for calibration. The requirement of meters calibration and verification in conditions that are as close as possible to working ones is necessary, but not always optimal, because of the high technical, time and financial costs required for carrying out this calibration (verification). Therefore, an evaluation of the results of comparing the calibration characteristics of meters obtained in air at atmospheric pressure and on natural gas at high pressure is a crucial task.
2. Insufficiently developed metrology infrastructure - currently there is just a small number of calibration labs working on natural gas at high pressure.
3. The normative base that regulates the calibration of meters in different environments and pressures is not developed - currently there are no compulsory normative documents regulating compulsory testing on the working medium, as well as documents defining the criteria for selecting the medium and pressure for verification of ultrasonic gas meters.



Introduction



Analysis of recent researches and publication

Classification of gas meters in accordance value of with maximum permissible error

Class	MPE	MPE	AGA Report №9	ISO 170891:2010	OIML R 137-1&2	Directive 2014/32/EU (MID)	RGazprom 5.13 - 2010
	Qmin<Q<Qt, %	Qt<Q<Qmax, %					
0,3	±0,6	±0,3					X
0,5	±1,0	±0,5			X		X
0,7	±1,0	±0,7					X
	±1,4>12"	±0,7>12"	X				X
	±1,4>12"; ±1,4<12"	±0,7>12"; ±1,0<12"		X			X
1,0	±2,0	±1,0			X	X	X
	±1,4<12"	±1,0< 12"	X				X
1,5	±3,0	±1,5			X	X	
	±2,0>12"; ±2,0<12"	±1,0>12"; ±1,5<12"		X			



Analysis of recent researches and publication

Analysis results:

- analysis of the main international and state regulatory documents, as well as industry standards demonstrates the lack of a unified approach in the requirements for determining the working medium and pressure when calibrating and periodically checking ultrasonic gas meters;
- requirements for testing, calibration and verification of ultrasonic gas meters, depending on the class of their accuracy and the parameters of the working medium, are either contradictory or recommendatory in nature. There are no clear criteria for choosing the medium and pressure for testing ultrasonic gas meters;





Ways to solve problems

1. Development of the metrological base - creation of calibration rigs for high pressure on natural gas as testing medium.
2. Definition of regulations and criteria for justifying the need to calibrate ultrasonic gas meters under operating conditions.
3. Determination of accuracy classes of meters for which it is necessary to perform calibration on natural gas.
4. Investigation of the possibility of confirming metrological parameters of ultrasonic gas meters of class 0.5; 0.7 and 1.0 in the range $Q_t < Q < Q_{max}$ under operating conditions after calibration on air at atmospheric pressure.
5. Development of methods and algorithms for adequate verification of meters on air at atmospheric pressure.



2-Path Ultrasonic Flow Meter Energoflow GFE 202



DN mm	Dimension Type	Volumetric flow rate			
		Threshold Qthr	Minimal Qmin	Transition, Qt	Maximal Qmax
50	G100	0.7	1	8	160
80	G250	1.9	2.7	20	400
100	G400	3	4.2	33	650
150	G1000	6.8	9.5	80	1 600
200	G1600	12	17	125	2 500
250	G2500	19	26	200	4 000
300	G4000	28	38	325	6 500
400	G6500	47	67	500	10 000

4-Path Ultrasonic Flow Meter Energoflow GFE 404

Flow velocity, m/s	Inner Diameter (DN), mm	No. of Measurement Channels	Maximum pressure, MPa	Accuracy, %
0.15 to 45	150...400	4	1.6; 6.3; 10.0; 16.0;	0.5 (0.2)



DN mm	Actual flow rate [m ³ /h]			Max. Velocity*	
	Qmin	Qt	Qmax	[m/sec]	[ft/sec]
150	10	80	2500	50	164
200	17	125	4000	45	148
250	26	200	6500	40	131
300	40	325	10000	33	108
400	67	500	16000	33	108

The algorithm of comparative tests of GFE gas meters of accuracy class 1.0% and 0.5% on different media and pressures:

1. Calibration of the meters on air at atmospheric pressure
2. Verification of the meters on air at atmospheric pressure on a reference installation
3. Entering medium parameters corresponding to the conditions of verification and operation.
4. Verification of meters on the working medium (natural gas) at operating pressure

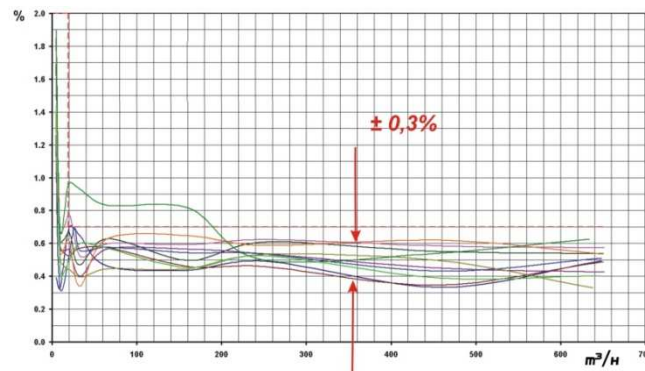
Conformity assessment of the measuring instruments, produced by national manufacturers, to the requirements of the main international regulatory documents (directives, regulations, recommendations, standards) has nowadays become the paramount issue. To this end, Energoflow AG carried out tests of **Energoflow GFE 202** and **Energoflow GFE 404** ultrasonic gas flow meters to meet the requirements of international regulatory documents.



Test results:

Metrological tests were conducted in accordance with the requirements of international recommendations and OIML R 137-1 & 2 in laboratory and actual (field) conditions based on the following criteria:

- repeatability and error evaluation after the first and second installation, dismantling;
- with a single 90 ° bend before the measuring section of the pipeline;
- with two 90 ° bends in perpendicular planes;
- with diameters deviations (-3%, + 3%) of the measuring pipeline and the in-line (flanged) section of the meter;
- with an expander;
- with a reducer;



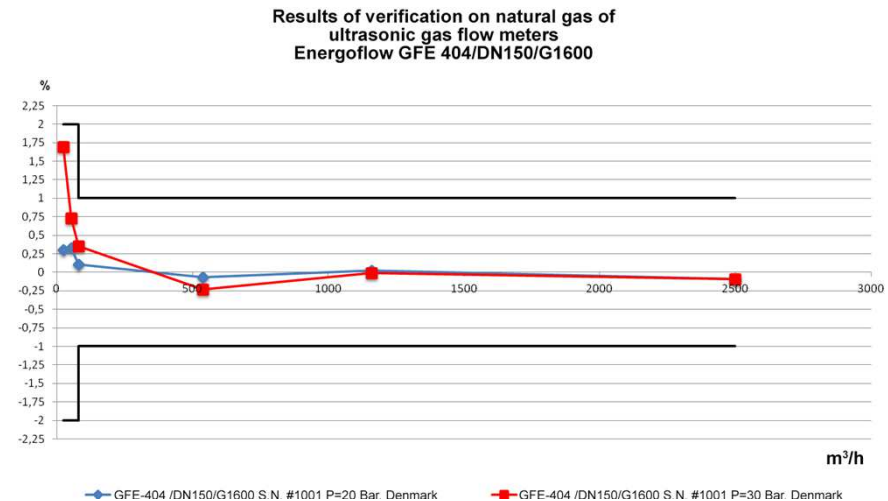
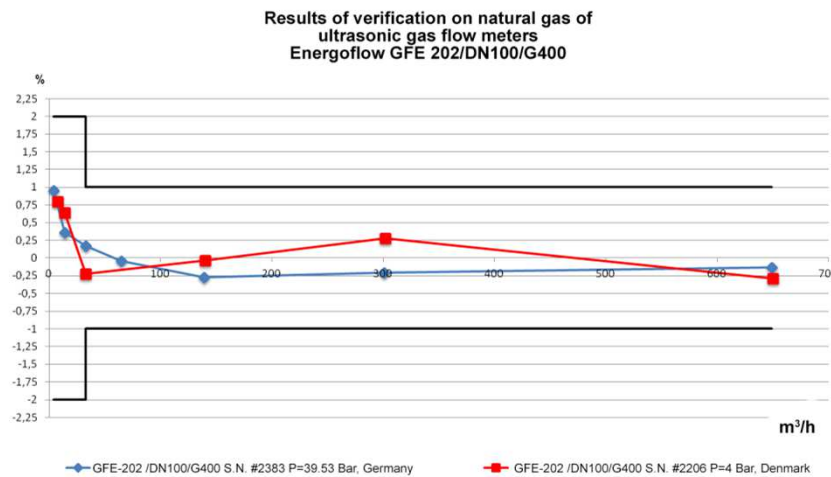
The results are presented the form of errors curves.
The maximum error does not exceed $\pm 0,3\%$.



Main part



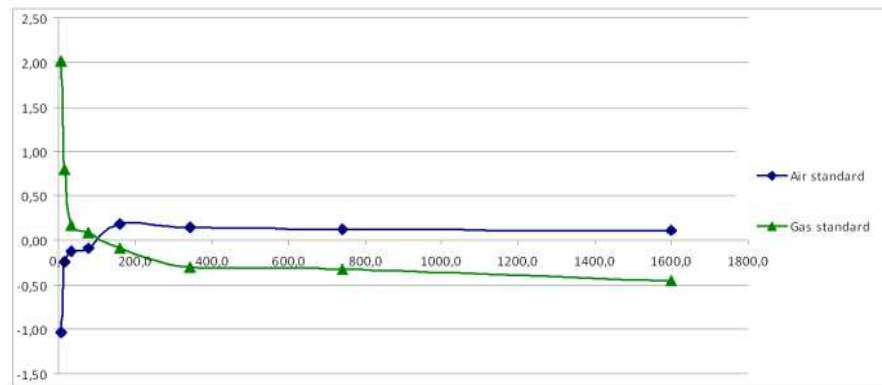
The Energoflow GFE 202 and Energoflow GFE 404 meters confirmed their characteristics in the certified European calibration facility “FORCE Technology” (Denmark). Tests were conducted on natural gas as operating medium in 2015 year. According to the test results, the error value did not exceed -0.22%. The results are presented on the charts



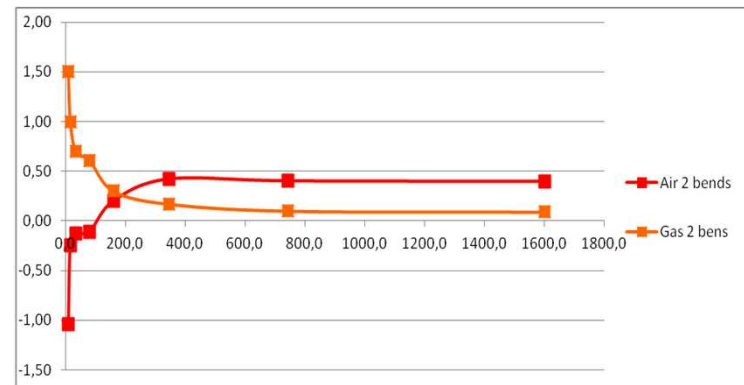
Main part



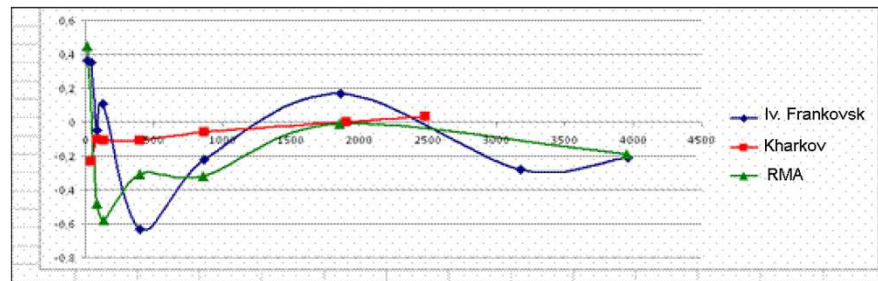
Tests results confirmed the Energoflow GFE 202 and Energoflow GFE 404 compliance with the requirements of OIML R 137-1 & 2 and MID 2014/32 / EU.



Test results of the Energoflow GFE 202 at RMA calibration facilities (standard conditions, air, natural gas) 2016 yr



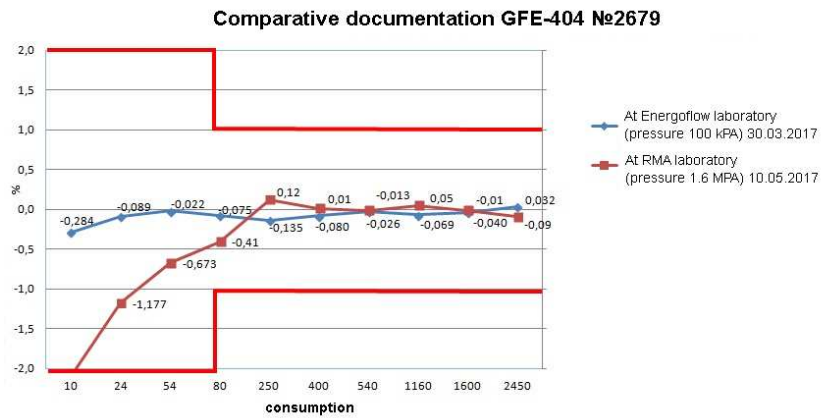
Test results of the Energoflow GFE 202 at RMA calibration facilities (two bends in different planes, air, natural gas) 2016 yr



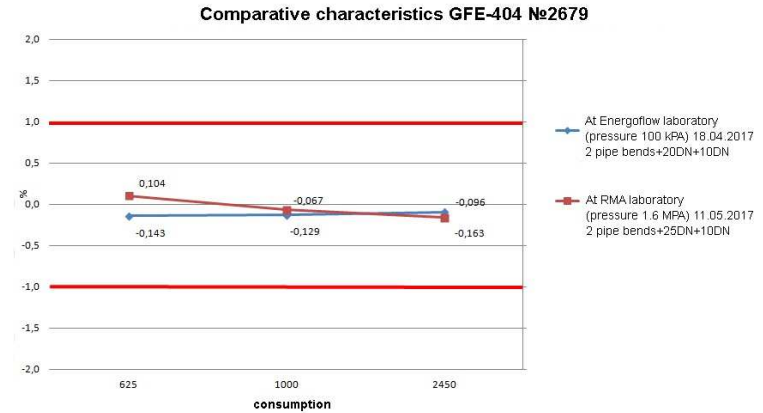
Comparative results of Energoflow GFE 202 tests on different mediums and at various pressures 2016 yr



Main part



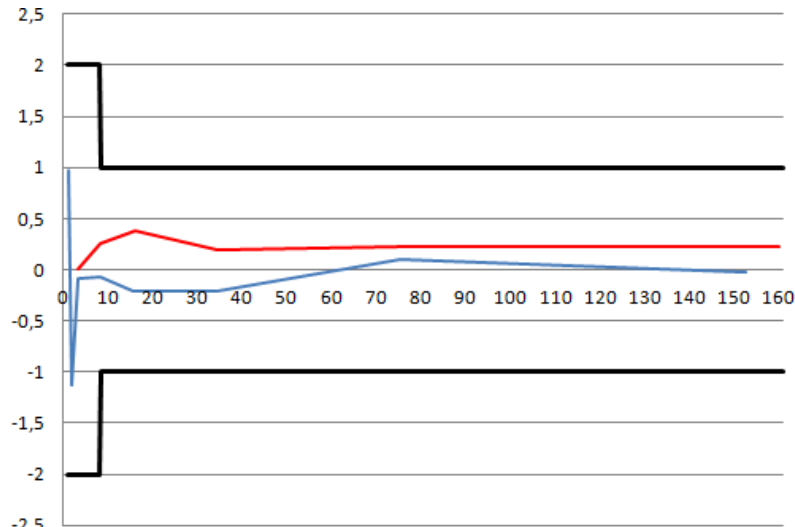
Test results of Energoflow GFE 404 at RMA calibration facilities (standard conditions, air, natural gas) 2017 yr



Test results of Energoflow GFE 404 at RMA calibration facilities (two bends in different planes + half-moon opening, air, natural gas) 2017 yr

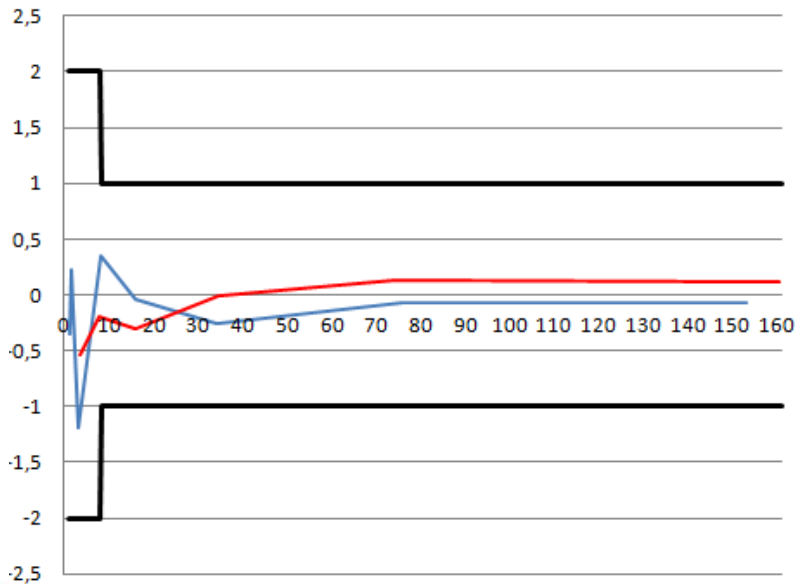


Main part



— At Energoflow laboratory, Air
— At RMA laboratory, Gas

**Test results of Energoflow GFE 202
DN 50, PN 10 MPa, № 3389
(standard conditions, air, natural gas)
2018 yr**



— At Energoflow laboratory, Air
— At RMA laboratory, Gas

**Test results of Energoflow GFE 202
DN 50, PN 10 MPa, № 3390
(standard conditions, air, natural gas)
2018 yr**



1. Ultrasonic gas meters **Energoflow GFE 202** and **Energoflow GFE 404** showed good stable results in all types of tests and for different working mediums.
2. Despite the general tendency for calibration (verification) of ultrasonic gas meters under working conditions, this requirement is not always appropriate. Due to a significant reduction in the cost of calibration and associated transport costs during periodic maintenance, the proposed algorithm enables to expand the possibilities of using ultrasonic gas meters after calibration on air for natural gas measurement without additional calibration at process pressure on natural gas.
3. The obtained results open prospects for further research and improvement of technologies of ultrasonic gas meters in order to accumulate statistics of test results and the possibility of approving the described methodology at the regulatory level.



Conclusions



4. As a result of tests carried out jointly with PTB, MID certificate No. DE-16-MI002-PTB008, Revision 3 for **Energoflow GFE202** and **Energoflow GFE404** was obtained and report class 0.5 according to OIML R137 1&2, section 5.3.2. for **Energoflow GFE404** was issued.



KBS
Konformitätsbewertungsstelle



EU-Baumusterprüfbescheinigung
EU Type-examination Certificate

Ausgestellt für: Energoflow AG
Ringstrasse 28
4600 Otten
SCHWEIZ

gemäß: Anhang II Modul B der Richtlinie 2014/32/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die Bereitstellung von Messgeräten auf dem Markt.
Annex II Module B of the Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments.

Geräteart: Gaszähler
Type of instrument: Gas meter

Typbezeichnung: GUVR-011 A2.2 / A4.4 oder / or Energoflow GFE 202 / GFE 404
Type designation:

Nr. der Bescheinigung: DE-16-MI002-PTB008, Revision 3
Certificate No.:

Gültig bis: 22.12.2026
Valid until:

Anzahl der Seiten: 26
Number of pages:

Geschäftszeichen: PTB-1.42-4067170
Reference No.:

Notifizierte Stelle: 0102
Notified Body:

Zertifizierung: Braunschweig, 12.09.2017
Certification:

Im Auftrag: Siegel
On behalf of PTB:



Dr. Rainer Kramer



Bewertung: Im Auftrag
Evaluation:



Dr. Roland Schmidt



Bericht
Report



Ausgestellt für: <i>Issued to:</i>	Energoflow AG Ringstrasse 28 CH-4600 Otten
Bezug: <i>In accordance with:</i>	International Organisation of Legal Metrology International Recommendation OIML R137 1&2 Gas meters, section 5.3.13 'Flow disturbance'
Genauigkeitsklasse: <i>Accuracy class:</i>	0.5 gemäß / according to OIML R137 1&2, section 5.3.2
Geräteart: <i>Type of instrument:</i>	Ultraschallgaszähler Ultrasonic gas meter
Typbezeichnung: <i>Type designation:</i>	GLUVR-011 A4.4 oder / or Energoflow GFE404
Nummer der Baumuster-Prüfbescheinigung: <i>Number of the type-examination certificate:</i>	DE-16-MI002-PTB008 Revision 3
Ort und Datum der Prüfungen: <i>Place and time of the tests:</i>	(1) Kharkiv, Ukraine; 26.4.2017 (2) Rheinau, Germany; 10.5.–12.5.2017

Anzahl der Seiten: 4
Number of pages:

Geschäftszeichen: PTB-1.42-4067170
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On behalf of PTB:



Dr. Roland Schmidt



Siegel: Siegel
Seal:



Dr. Rainer Kramer

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