

Reliability of instrumental recording of the natural gas

UDC 681,121

Y. M. Vlasiuk

Candidate of Technical Sciences

Naftogaz of Ukraine National Joint Stock Company

A.I. Kompan

Regional Gas Company LLC

L.Y. Vlasyuk

Ukrmetrteststandard SE

The comparison of industrial natural gas flow meters, functioning of which is based on different metering methods usage, was made, recommendations on the optimization of choice of the meter's type in accordance with operation conditions were given.

Key words: gas flow, meters, natural gas accounting, meter inaccuracy, metrology.

In the 90s' of the last century Ukraine inherited the Soviet all-national calibration scheme for means of measuring the volumetric flow of gas according to the requirements of GOST 8.143-75. This calibration scheme made it possible to use the flow meters and gas meters with relative permissible error $\max \pm 5\%$.

Since January 01, 1997 Ukraine, in accordance with DSTU 3383, implemented the state calibration scheme for volume and volumetric gas flow measuring tools, which allows using the working means of measuring the volumetric gas flow with relative permissible error **max $\pm 4\%$** . For natural gas, according to the requirements of the Rules of Measuring the Natural Gas During Its Transportation by the Gas Distribution Networks, Supply and Demand, approved by the order of the Ministry of Energy dd. December 27, 2005 No. 618, this figure reaches **$\pm 3 (2.5)\%$** .

The operation of the majority significant natural gas consumption metering units (GMU) operated in the former Soviet Union is based on the use of the method of alternating pressure drop (using the diaphragm). In the course of certification of such GMUs the procedures for obtaining the consumption unit from the reference standards is unavailable, i.e. this method is **indirect** and associated with subjectivity of estimates. This leads to many conflict situations evaluated with much greater amounts of money than the cost of advanced metering. In addition, the accuracy of measurement with this method is affected significantly by the diaphragm pollution [1].

Table 1

Characteristics of the natural gas consumption measuring appliances based on various measurement methods

Gas consumption measurement method	Error in The main range (%)	Ability to understate the readings during operation	Excessive pressure (kgf/cm ²)	Loss of pressure (kgf/cm ²)	Optimal diameter (mm)	Q_{\min} / Q_{\max}	Dependence From gas density	Advantages	Disadvantages	The maximum sensitivity of $Q_{\max} / Q_{\text{sensitivity}}$
Method of alternating pressure difference	0.8 - 1.5	+	1 - 100	0.3	200 - 700	1/3 (6)	+	simplicity	underestimation impressions small range costs	50
Using the turbine meter	0.5 - 1.0	in case of damage	1 - 100	0.3	150 - 600	1/50	-	high accuracy	filter (compulsory) Small consumption range	150
Using the rotary meter	0.5 - 1.0	in case of damage	3 - 100	0.3	32 - 100	1/250	-	high accuracy	filter (compulsory)	1000

Using the vortex meter	1.0	-	0 - 10 0 8 - 100	0.2	150 - 400	1/10	+	insensitivity to contamination	small consumption range	15
Using the ultrasonic meter	0.5 - 1.0	-	0 - 10 0	0.2	50 - 1400	1/1501/250	-	insensitivity to contamination, high accuracy	-	1000
Using the averaged tube	1.0	-	-	0.05	300 - 1400	1/3 (6)	+	simplicity	low accuracy	30

Table 2

Parameter / Year	1997	2005	2011	2015
CONSUMPTION Working standards, the method of transfer (meter + air / gas or? P + p)	0.5 ÷ 0.7 1.5	0.3 ÷ 0.7 1.0	0.3 ÷ 0.7 0.6 ÷ 1.0	0.15 ÷ 0.5 0.2 ÷ 0.5
TEMPERATURE	1	0.5	0.2	0.1
PRESSURE	1	0.5	0.1 ÷ 0.25	0.05 ÷ 0.15
CALCULATION (reduction to standard conditions)	> 2 (manually)	> 1 (manually, some computer)	0.05 (corrector)	0.02 (corrector)
TOTAL	> 5	3	1.5	0.5 ÷ 0.9

Table 3

The cost of verification (calibration) of FTA for natural gas consumption (production environment - natural gas) in Europe

Conventional diameter of consumption metering appliances, mm	Number of gas of consumption metering appliances in Ukraine	European price for verification (calibration) per unit, EUR thousand	Total cost of verification, EUR thousand
Ukrtransgas PJSC, Ukrgazvydobuvannia PJSC, Chornomor-naftogaz PJSC, Ukrnafta PJSC			
≥ 700	> 50	18x1.4*	1,300
400, 500	> 100	10x1.4*	1,400
200, 300	> 200	4x1.4*	1,100
150	> 1000	3x1.4*	4,200
TOTAL, items 1 to 4	> 1300	-	8,000
Consumers			
500, 700	> 50	12x1.4*	800
300, 400	> 150	6x1.4*	1,200
200	> 1,000	3x1.4*	4,200
150	> 2,000	2.2x1.4*	8,400
100	> 2,000	2x1.4*	5,600
TOTAL, items 5 to 9	> 5,200	-	22,200
TOTAL	> 6,500	-	30,200

* VAT and customs fees

Due to the advanced international experience, the experts of Naftogaz of Ukraine National Joint Stock Company developed a concept of creation of the unified system of natural gas accounting, which was approved by the Cabinet of Ministers of Ukraine dated August 21, 2001 No. 1089. The main goal is the creation of systems for gas, ensuring the high reliability of measurement of the gas volume.

Today the advanced foreign and domestic firms developed the modern natural gas meters, the error of which is less than **0.5%** (Table 1). Their introduction in Ukraine is constrained primarily due to the lack of the required metrological support.

The analysis of the former error of the natural gas metering instrument is still recorded and its expected status after implementation of the major provisions on the Concept of a Unified System for Natural Gas Metering in Ukraine is presented in Table. 2.

Table 2 shows the following points.

Through the introduction of modern electronic correctors a significant reduction of the natural gas appliances error is marked.

The error of polynomials embedded in the currently known methods of measurements using the variable pressure drop (using the diaphragm), in the best optimal ranges of consumption, pipeline diameters and module values is 0.6-0.8%. In addition, in the course of measurement using this method in the operating conditions there is an error of the primary converter of pressure drop and error in gas density determination.

The commensurate error is observed upon measurement of natural gas consumption by meters calibrated (verified) at stands existing in Ukraine, the working environment is which is air (stand error is 0.3%, the error due to a mismatch between the working environment and pressure is about 0.6%).

The noticeable error reduction is possible when using the methods proven in the world's best practice, namely the introduction of modern s precision meters calibrated at the stands in conditions close to the working ones, at the working pressure and with the natural gas.

A very small measurement error of the related parameters (temperature, pressure, gas composition) under current conditions, which can frequently be neglected, becomes significant during the procedure of bringing to standard conditions and measuring the gas flow in the working conditions with an accuracy of about 0.5 %. That is, in view of the error of 1% when measuring the gas consumption, it is permissible to neglect the pressure measurement error of 0.25% or the temperature measurement error of 0.65°C. For the expected condition these errors will become material. The modern measuring devices are able to provide significantly better performance accuracy, but the relevant metrological software, unfortunately, is still lagging behind.

Based on the real needs and operation conditions of specific sites, we recommend:

at all GMS (both with meters of all types and diaphragm) it is required to install the effective filters without valves between them and counter or diaphragm as a possible source of contamination);

for large GMS (for example, with consumption in standard conditions above 5,000 m³ per hour) it is feasible to use two accounting complexes with various measuring techniques connected in series;

GMS using the method of variable pressure drop with unstable gas composition (if the gas density change is fixed at 5 to 10 g per m³ in standard conditions), the flow density meters should be included;

at the newly created and renovated GMS it is required to implement the complexes (counter with corrector) implementing the functions of adjusting the additional meter errors depending on the temperature and working environment pressure change or the Reynolds number;

issue of flow meters, in which the relative error in the basic range upon manufacture completion is 0.5%, and during the operation - 1%;

continue the establishment and operation of stands for calibration and long-term testing of industrial meters at "natural gas" working environment with involvement of mobile standards of the Metrology Centre in Boyarka;

during issue and after repair the gas meters shall be calibrated at the stands with "natural gas" working environment under working pressure and checked at the stands with "air" working environment at atmospheric pressure and in the course of the next calibration at stands with "air" working environment at atmospheric pressure.

The cost of verification (calibration) of the natural gas consumption MAs in European metrological institutions accredited to perform such works at natural gas is presented in the table 3.

Conclusion

Thus, according to the results of the performed analysis we can state as follows [2]:

A significant error reduction of the instrument for natural gas accounting, the need for which is dictated by the sharp increase in gas prices is possible only due to simultaneous introduction of modern measuring appliances (MA) and associated metrology software;

It is possible to create a system of natural gas accounting with measurement error in the basic range less than **0.6%**. The required domestic metrological software is being **created already**, and MAs are legalized and **available**;

The implementation of verification (calibration) of meters for "natural gas" operation environment shall take place in stages:

- All turbine, ultrasonic and rotary meters working at high pressure;

- All ultrasonic and rotary meters working at medium pressure.

References

1. **Vlasyuk Y.M.** Concept of a unified system for natural gas metering in Ukraine (optimizing the implementation of industrial meters with various methods of measurement)/Y.M. Vlasyuk, M.I. Chupryn. - P. 73-75.
2. **MP 412/03-2010.** A method of checking the technical condition of the GMS using EK-B installation / V.I. Kartasheva, N.V. Babichenko, V.S. Bondarenko, Y.M. Vlasyuk [et al.]. - 21 p.

Article Authors



Vlasjuk Yaroslav Mykhaylovych

Candidate of Technical Sciences, an expert in the field of automation of production processes, accounting of natural gas and metrology. He graduated from IFING. The main directions of his scientific studies is creation of electronic fiscal means of instrumental accounting, improvement of metrological software for natural gas metering appliances, calibration (verification) of industrial meters by working pressure; checking the technical condition (metrological characteristics) of the natural gas metering units in operating environment; implementation of consumption metering complexes with regulated total measurement error, self- diagnostics of the natural gas metering units.



Compan Artem Igorovych

He graduated from Kondratyuk National Technical University of Poltava with the major in Equipment for Oil and Gas Industry. His research interests are related to accounting and reasonable use of natural gas energy and savings in the industry.



Vlasyk Lilya Yaroslavivna

2nd category engineer of Ukrmetrteststandard SE. She graduated from KPI with the major in metrology and measuring equipment, as well as linguistics. The main line of her work is verification of the natural gas consumption measuring appliances.