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Reliable instrumental metering of natural gas is the key to Ukraine's energy independence

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Abstract

By virtue of geographical and historic factors, Ukraine has been playing an important role in oil and natural gas deliveries to European energy markets. Such status is basically attributed to the fact that West and Central European countries, while being rather big consumers of natural hydrocarbons, have shortage in their own energy resources.

On the other hand, major natural gas and oil reserves are concentrated in the Russian Federation, Caspian region and the Gulf area. Currently Ukraine has become a major juncture in the transit of gas and oil from Russia and Kazakhstan to European markets. The expected increase in consumption of natural hydrocarbon resources, as well as their uneven distribution make Ukraine, owing to its suitable geographical location and the developed gas and oil network, an "energy bridge" between the exporting countries and consumers in the industrialized Europe.

In the article the author considers the modern gas supply system of Ukraine. The author carried out a study on the technical feasibility of calibration of flow meters on the environment of natural gas under pressure. Currently in Ukraine calibration is performed only in the air. This does not make it possible to reduce the error in the instrumentation of natural gas. Given the volume of natural gas consumption in the country (about 20 billion m^3/year), this leads to huge non-production losses, negative impact on economic performance and inflated cost for end users. The European experience was analyzed: PTB, DNV, PIGSAR, SICK, INOTECH. Modernization of the gas industry of Ukraine is proposed.

Keywords: uniformity of measurements; validation; metrological traceability (traceability); uncertainty; implementation.

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1. Introduction

The existing system of measuring the quantity and quality of natural gas in Ukraine does not meet modern requirements of international standards ISO, EN, recommendations of the International Organization of Legal Metrology (OIML) and Common Business Practices (CBPs) of the European Association for the Streamlining of Energy Exchange (EASEE – gas) for natural gas metering. In order to implement the requirements of international standards for measuring volumes and determining the quality of natural gas produced, transported and sold in Ukraine, the company NJSC "Naftogaz of Ukraine" with the financial support of the European Commission (Program TACIS-INOGATE 98/99.03 "Financing small investments in regional oil and gas infrastructure in Ukraine, Belarus and Moldova") established the Metrology Center (hereinafter – MC) (international name – Eastern European Regional Center for Metrology of Natural Gas, Oil and Petroleum Products) in Boyarka in 2001.

As of now, a powerful laboratory complex of the Branch "Center of Metrology and Gas Distribution Systems" (hereinafter – CMGS) has been created, equipped with laboratory and reference equipment of the world's leading manufacturers. Its purpose is the systematic and regular testing and calibration of means of accounting and measurement of natural gas parameters used in the oil and gas industry of Ukraine, with the maximum coverage of their number and range.

The MC includes laboratories of flow, pressure, temperature, humidity, density and physicochemical composition of natural gas, which are equipped with unique equipment and can provide a wide range of metrological services for oil and gas companies of Ukraine, this will ensure international cooperation in establishing a unified gas metering system; this will help reduce the level of error in measuring natural gas volumes in instrument metering, there will be a real implementation of European and international standards in the national oil and gas industry, etc. The main competitive advantage of MC is the ability to calibrate gas meters in conditions as close as possible to real operating conditions at different pressures and costs using natural gas as a working medium [1–3].

2. Research of the European experience of solving the problems of natural gas metering

The historical experience of solving the problem of systemic imbalance of natural gas in its measurement and calibration of its measuring instruments can be illustrated by the example of the Dutch gas transmission system. GTS consists of 12.000 km pipelines, yearly volume: 100 billion (1011) m^3. Monthly check on total system: entry stations: 27, delivery stations (physical):

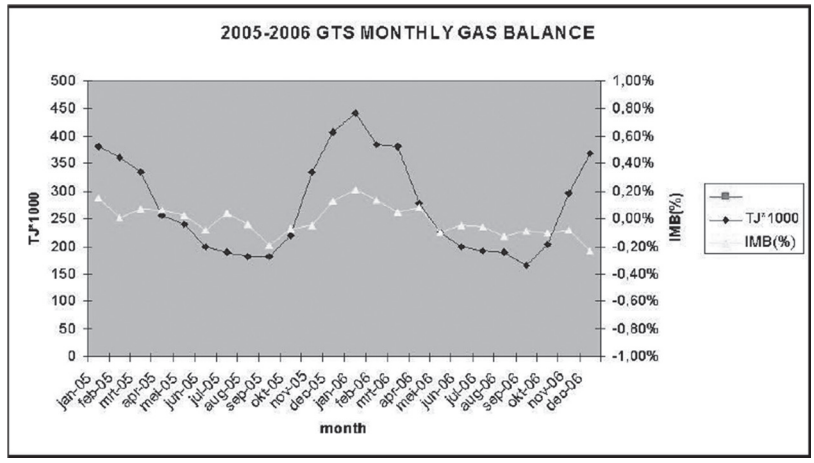

Fig. 1. 2005–2006 GTS monthly gas balance in the Netherlands

1100 (350 Industry + 750 domestic), export stations: 16, UGS stations including LNG: 5, compressor stations: 9, Linepack (calculated in state-estimation system at Central Command Post).

Historical records of reconciliation in the Netherlands records start in 90's (large imbalance position, mainly positive ~>1%). In the period from 1995 to 2005, the annual imbalance decreased to less than 0.05%, and the monthly less than 0.2%. This is shown in Fig. 1.

The input measuring stations and internal consumption measuring points were renovated by replacing the old flow meters with modern ultrasonic meters. A metrological center has also been set up in Groningham to monitor the stability of new process meters and their primary and periodic calibrations. Yellow highlighted: Changes of flow technology replacing orifice towards technology (e.g. ultrasonic) which can be calibrated and checked impacts the UFG and improves the imbalance position of the grid owner.

Implementation of billing systems based on capacity. Improvement in quality of data handling. Data scrutinized and data collection automated. Enlarging areas for gas quality measurement (more field GCs). More proper accounting of unaccounted gas losses (e.g. leaks, maintenance actions and incidents).

To summarize it up, it should be emphasized that gas calibration on high pressure gas is a key instrument to obtain improvement or reduction of the (grid) imbalance; reduce potential (large) financial risk; provide traceability towards international standards. Awareness about mismeasurement and risk of financial losses will increase the need for calibration and recalibration. A calibration facility and more broad a metrology institute assures that knowledge on metering and calibration issues is present and growing (e.g. by training) and systematic errors can be brought close to zero.

DNV can assist on all levels (commercially, technically, systems and organisation) to achieve the goals in metering and calibration for Ukraine [4, 5].

Due to the rather high demand for metrological services for calibration of natural gas meters, the queue for these procedures at some European calibration stands is up to six months. Taking into account

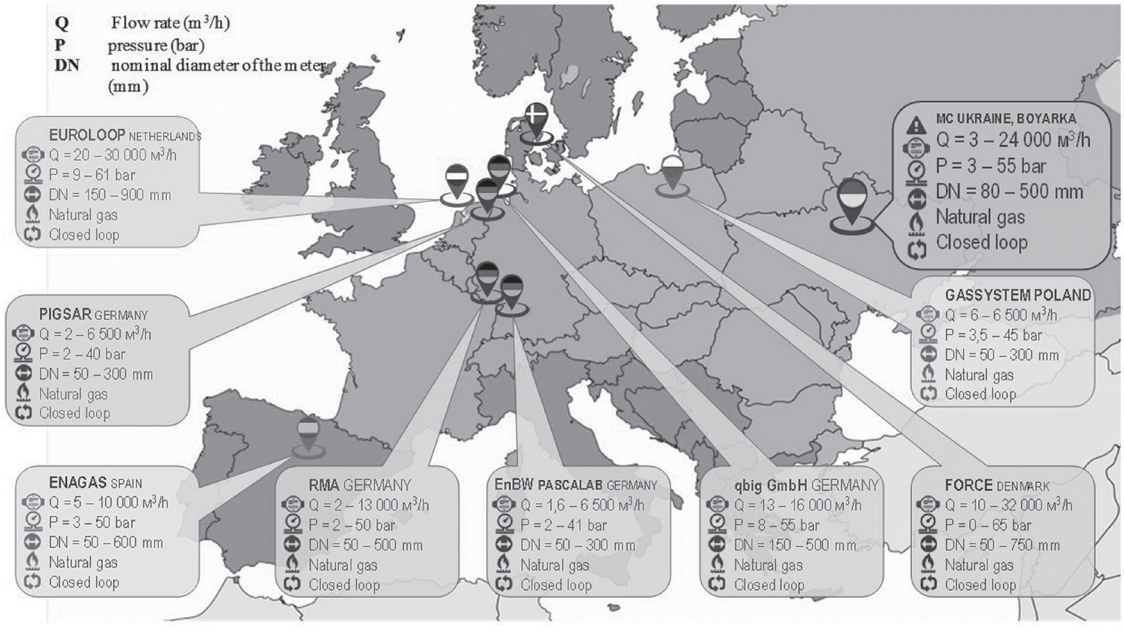

Fig. 2. Location of existing calibration stands in Europe

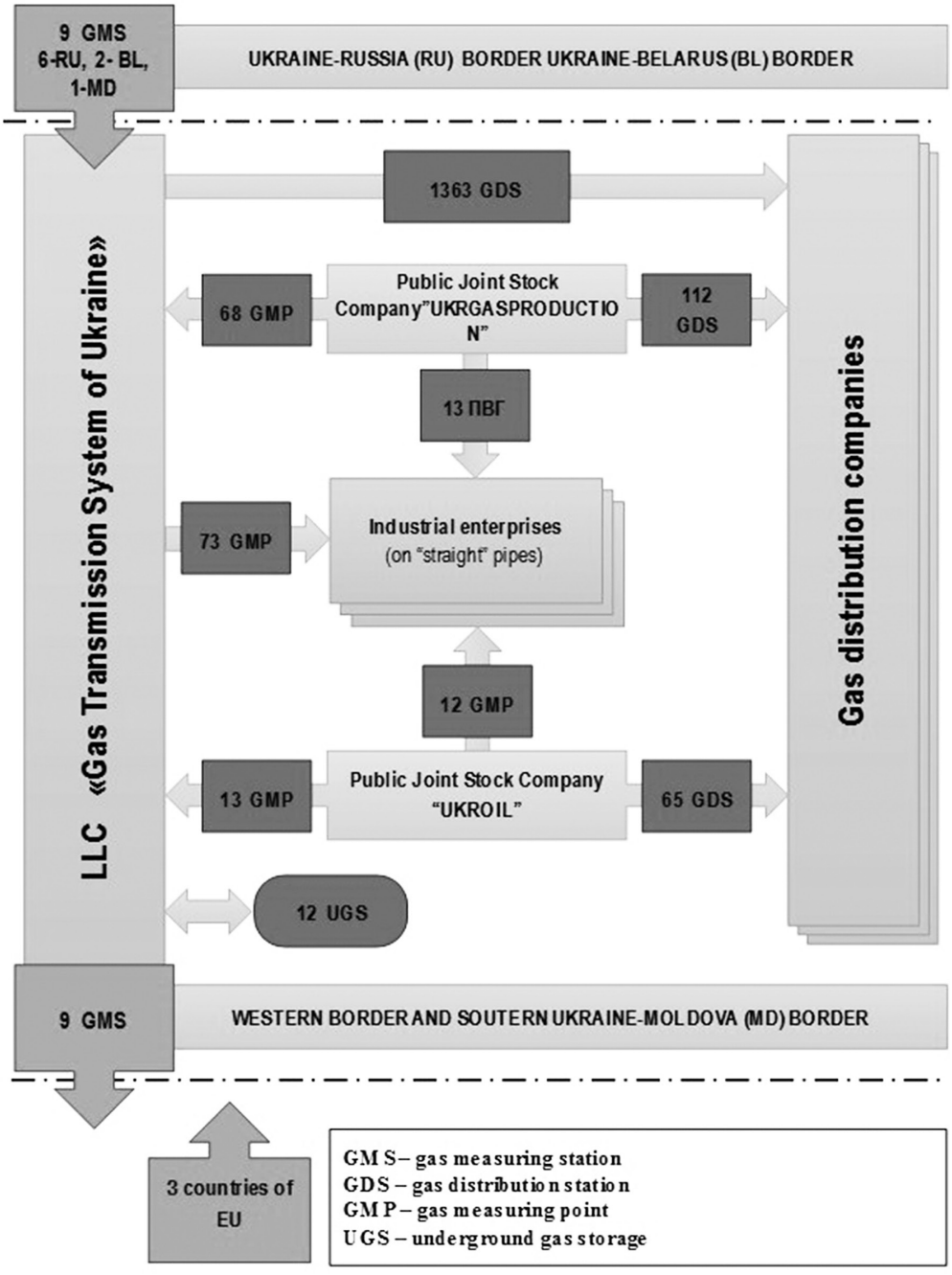

Fig. 3. Structural scheme of accounting for natural gas supply and distribution

the tendencies to increase the requirements for the accuracy of natural gas metering and a significant increase in the number of measuring instruments each year, it becomes obvious that there is a certain lack of technical capabilities for their periodic calibration. Therefore, in Europe, existing calibration stands are being actively modernized and new ones are being built. As an example, in 2019, a high-pressure test stand was built for qbig gas meters in Leer, northern Germany. Which is the world's first bidirectional stand for calibrating industrial meters on natural gas under high pressure. The calibration is carried out with natural gas, which originates from a high-pressure pipeline of GTG Nord GmbH and which, after the test, is fed via a corresponding measurement into the local gas distribution network. This is another way to protect the environment by reducing gas emissions to almost zero [6, 7]. Metrological centers of Europe, where calibration of gas meters in the ring mode on natural gas under pressure is carried out, indicating their main technical characteristics and geographical location (see Fig. 2).

3. Measuring infrastructure of the national gas supply system and the way of its metrological support

Scheme of distribution of boundaries of balance affiliation and natural gas transmission points between operators and interconnectors in the gas supply system of Ukraine. This scheme (see Fig. 3) gives an idea of the minimum required number of FTAs used at metering points in the transfer points of balance affiliation.

Main competitive advantages of the Metrological Centre is the possibility calibration and verification of gas meters on working medium – natural gas under various pressures during the year, which meets the international and European requirements. For the first time in Ukraine, there will be such an opportunity to set the market in services for calibration of gas meters according to European requirements and to improve the accuracy of natural gas accounting, which is an extremely urgent requirement nowadays.

The current demand for large diameter meters (DN 500 – DN 1000) has decreased due to trends in the hydrocarbon market, which has recently been characterized by a reduction in natural gas consumption and transit volumes. In addition, there is no possibility of implementing the foreseen operating modes of the calibration rig, it is necessary to change the configuration of the calibration rig to provide independent and uninterrupted operation from the cross-country gas pipelines. These conditions give a no-alternative application of the loop-mode of the rig (calibration complex on natural gas) in the closed loop [8].

Capital investments for construction of the calibration rig and installation the necessary equipment (compressor installation, gas coolers, etc.) to operate in a closed loop.

The loop-mode will ensure the uninterrupted operation of the rig, regardless of the cross-country gas pipelines, as well as a significant reduction in the cost of calibration services, which is the key to the commercial attractiveness of the Metrological Centre for consumers in Ukraine and abroad.

4. Conclusion

Requirements for calibration of gas meters under conditions corresponding to the operating conditions (on natural gas under operating pressure) are regulated by the current standards for industrial gas meters – DSTU EN 12261:2006, DSTU ISO 17089-1:2014. According to the operating instructions for gas meters, the error in their calibration on the working medium – air and natural gas, differs by 2 times, namely 1% and 0.5%, respectively. Thus, the maximum additional error of gas meters when calibrating in air, and not in natural gas, is 1.0% – 0.5% = 0.5%. The real additional measurement error will be in the range of 0.25–0.5%. Given the total annual turnover of natural gas in the national gas industry, it becomes clear that the improvement of metering will make it possible to significantly optimize economic performance in this area.

Достовірний приладовий облік природного газу – запорука енергонезалежності України

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Анотація

З огляду на географічні та історичні причини Україна відіграє важливу роль у забезпеченні енергетичного ринку Європи природним газом. Передумовою такого становища є той факт, що країни Західної та Центральної Європи є доволі значними споживачами природних вуглеводнів, але власними ресурсами цих енергоносіїв вони забезпечені недостатньо. Водночас основні запаси природного газу зосереджені в Російській Федерації, країнах Каспійського регіону та Перської затоки. Тому Україна є важливим вузлом транзитних передач газу і нафти з Росії та Казахстану на європейський ринок.

У статті автором розглянуто сучасну систему газопостачання України. Враховуючи вимоги чинного законодавства України, всі лічильники природного газу, що працюють під тиском від 0,4 МРа та вище, мають проходити обов'язкову процедуру повірки раз на два роки. Загальна кількість витратомірів газу, що застосовуються в національній системі газопостачання, – декілька тисяч. Більшість із них – вимірювальні комплекси змінного перепаду тиску (діафрагми), які працюють в обмеженому діапазоні тиску. Враховуючи зміну режимів роботи магістральних газопроводів та підвищення вимог до точності вимірювань, а також стійкості до умов експлуатації та збереження захисту й передавання даних вимірювань обсягів природного газу та властивостей потоку, стає очевидним, що ці витратоміри не відповідають сучасним вимогам.

Автором було проведено дослідження щодо технічної можливості здійснення калібрування витратомірів у середовищі природного газу під тиском. Наразі в Україні калібрування здійснюється лише на повітрі. Це не дає можливості зменшити похибку під час приладового обліку природного газу. А отже, додаткова похибка при калібруванні на повітрі множиться від ЗВТ до ЗВТ. Враховуючи обсяг споживання природного газу у країні (близько

20 млрд м^3 на рік), це призводить до величезних невиробничих втрат, негативного впливу на економічні показники та завищеної вартості для кінцевих споживачів.

Проаналізовано європейський досвід провідних компаній: PTB, DNV, PIGSAR, SICK, INOTECH. Запропоновано модернізацію газової галузі України.

Ключові слова: єдність вимірювань; валідація; метрологічна простежуваність (простежуваність); невизначеність; імплементація.

Достоверный приборный учет природного газа – залог энергонезависимости Украины

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Аннотация

В силу географических и исторических причин Украина играет важную роль в обеспечении энергетического рынка Европы природным газом. Причиной такого положения является тот факт, что страны Западной и Центральной Европы – это довольно значительные потребители природных углеводородов, но собственными ресурсами этих энергоносителей они обеспечены недостаточно. В то время основные запасы природного газа сосредоточены в Российской Федерации, странах Каспийского региона и Персидского залива. Поэтому Украина является важным узлом транзитных передач газа и нефти из России и Казахстана на европейский рынок.

В статье автором рассмотрена современная система газоснабжения Украины. Было проведено исследование относительно технической возможности осуществления калибровки расходомеров в среде природного газа под давлением. Сейчас в Украине калибровки осуществляются только на воздухе. Это не позволяет уменьшить погрешность при приборном учете природного газа. А значит, дополнительная погрешность при калибровке на воздухе умножается от СИТ к СИТ. Учитывая объем потребления природного газа в стране (около 20 млрд м^3 в год), это приводит к огромным непроизводственным потерям, негативно влияет на экономические показатели и завышает стоимость для конечных потребителей.

Проанализирован европейский опыт ведущих компаний: PTB, DNV, PIGSAR, SICK, INOTECH. Предложена модернизация газовой отрасли Украины.

Ключевые слова: единство измерений; валидация; метрологическая прослеживаемость (прослеживаемость); неопределенность; имплементация.

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