

2. P.G.Mikhailova. Development of Intelligent Decision Support System for Managing Safety of Chemical Production: Dis. ... Cand. of Tech. Sciences: 05.13.01. –M.: 2006. - 194 p.
3. Atsushi Tahara and Hideo Nagashima. Recent Topics Of Iridium-Catalyzed Hydrosilylation Of Tertiary Amides To Silylhemiaminals. Tetrahedron Letters Volume 61, Issue 4, 23 January 2020, 151423. <https://doi.org/10.1016/j.tetlet.2019.151423>.
4. Shunsuke Kotani, Makoto Nakajima. Recent Advances in Asymmetric Phosphine Oxide Catalysis. Tetrahedron Letters Volume 61, Issue 4, 23 January 2020, <https://doi.org/10.1016/j.tetlet.2019.151421>.
5. José Sebastião, Santos Neto Gilson Zeni. Ten Years of Progress in the Synthesis of Six-Membered N-Heterocycles from Alkynes and Nitrogen Sources. Tetrahedron. Volume 76, Issue 4, 24 January 2020, 130876. <https://doi.org/10.1016/j.tet.2019.130876>.
6. Justin M.Lopchuk. Five-Membered Ring Systems: Pyrroles and Benzo Analogs. Progress in Heterocyclic Chemistry. Volume 31, 2020, Pages 223-280. <https://doi.org/10.1016/B978-0-12-819962-6.00006-3>.
7. William R. Dolbier, Zhaoyun Zheng. Use of 1,3-Dipolar Reactions for The Preparation of SF5-Substituted five-Membered Heterocycles. Pyrroles And Thiophenes. Journal of Fluorine Chemistry. Volume. 132, Issue 6 June 2011 Pages 389-393.
8. Joule J. Chemistry of Heterocyclic Compounds: Textbook for Universities / J. Joule. [2nd revised. ed.: translation from English. F.V. Zaitseva, A.V. Karchava]. - M.: Mir, 2004.-728 p.
9. VI Minkin "Molecular Electronics on the Threshold of the New Millennium" // Russian Chemical Journal. 2000. Vol.44. No. 6, p.3-13.
10. Andreson H.J., Loader C.E., «The synthesis of 3-Substituted Pyrroles from Pyrrole» // Synthesis. 1985. p.353.
11. Irudayanathan F.M.; Noh J.; Choi, J.; Lee, S. Advanced Synthesis & Catalysis 2014, 356, 3433.
12. Tejedor D.; González-Cruz D.; García-Tellado F.; Marrero-Tellado J.J.; Rodríguez, M. L. J. Am. Chem. Soc. 2004, 126, 8390–8391.
13. Krostova S.E, Mikhaleva A.I, Nesteriko R.N, et al. "Pyrroles from Ketoximes and Acetylene" // Journal of Organic Chemistry. 1985. Vol. 21, p. 406-411.
14. Lia O J.Y., Shao P.L., Zhao Y., «Catalytic Divergent Synthesis of 3H and 1H Pyrroles by Cyclization of Alienates with Activated Isocyanides» // J. Am. Chem. Soc. 2015. V.137. №2. p.628-631.
15. U.Shokirov, S.Turabjanov, L.Rakhimova, F.Badridinova "Kinetics of Formation of Pyrroles from Acetylene, Ammonia and Amines" // Bulletin of Tashkent State Technical University, 2019. No. 2. p. 197-203.
16. U.Shokirov, S.Turabjanov, X.Kadirov, L.Raximova Development of single-stage methods of the catalytic process for producing pyrrol and its derivatives. // Uzbek Chemical Journal [Uzbekskiy ximicheskij jurnal]. 2019 №.2, P.73-77. (in Rus.)
17. S.Turabjanov, R.Tashkaraev. "Promoted Catalysts in the Technology of Liquid-Phase Organic Synthesis" // Chemistry and Chemical Technology. 2011 No. 3, p. 14-23.

APPLICATION OF THE DEVICE FOR MEASURING THE COMPOSITION OF BINARY GAS SYSTEMS

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Abstract. The methodology and results of measuring the density of natural gas using precision measurement of the composition of binary systems have been defaced. The application of the device for measuring the composition of binary gas systems is presented. Selected for the analysis methodology is weighing the cells and vessels after they have accumulated a sufficient amount of each component. The design of the sorption cell is substantiated under the conditions of ensuring the maximum value of the relative useful mass. For measuring the density of natural gas is determined by the needs of the development of measuring technology, the problems of the development of measuring instruments, the development of the socio-economic country. A large park of measuring instruments, a large number of various devices and elements, both domestic and foreign, require a careful approach to the tasks of ensuring the uniformity of measurements.

Keywords: measurement of gas parameters, density of natural gas, precision measurement, sorption cell, weighing cells and vessels.

Introduction.

Recently, it became necessary to measure the parameters and consumption of natural gas, devices and elements with various types of connectors used in the Republic of Uzbekistan with similar devices used abroad, where this type of measurement is well developed. This is confirmed by the fact that 11 countries took part in the latest international comparisons of reflection, including such leading countries in this area as Australia, England, Germany, Russia, and the USA.

Problem statement. Methodology and results of measuring the density of natural gas in a number of research and educational works. For example, precision measurement of the composition of binary systems, for example, to measure the moisture content of natural gas or as an initial setting for moisture state, virial coefficients or molar mass.

The gas mass measuring device can be used to analyze binary mixtures by the separation method using selective sorbents. The gas mass measuring device can be used to analyze binary mixtures by the separation method using selective sorbents. However, the selection of an appropriate substance selective with respect to natural gas components makes other measuring tasks promising. The methodology applied to water is reproduced below. Since the main measured quantities are the mass of water $m_{\text{вл}}$ and the mass of dry gas m_c , the installation therefore reproduces the unit size of the mass fraction of water

$$S_m = \frac{m_{\text{вл}}}{m} = \frac{m_{\text{вл}}}{(m_{\text{вл}} + m_c)} \tag{1}$$

However, as shown in [1], even at the reference level, it is advisable to recalculate this reproducible value (unit) into a molar fraction:

$$S_n = S_m [B_1(1 - B_9 S_m)]^{-1} = S_m \left[\frac{M_{\text{вл}}}{M_c} + \left(1 - \frac{M_{\text{вл}}}{M_c} \right) S_m \right]^{-1} \tag{2}$$

Thus, for the application of the developed installation, it is necessary to supplement the installation described above with cells that absorb water from the analyzed medium. For this purpose, two cell designs can be used: sorption and condensation, borrowed from [2].

Since the values of $m_{\text{вл}}$ and m_c are determined from the change in the values of the masses of cells and vessels, equation (2) is valid under the assumption of selective and complete separation of the analyzed mixture, i.e. when only water is absorbed in the cell (without dry gas), and in the vessel only dry gas enters (no water).

Let us assume that in $m_{\text{вл}}$, in addition to the water $m_{\text{вл}}^c$ itself, there is a dry gas $m_{\text{вл}}^c$, and in m_c there is water $m_c^{\text{вл}}$ and the dry gas m_c^c itself, i.e.

$$m_{\text{вл}} = m_{\text{вл}}^c + m_{\text{вл}}^c \text{ и } m_c = m_c^c + m_c^{\text{вл}} \tag{3}$$

Ultimately, we are interested in the content of pure water in the mixture:

$$S_m^u = \frac{(m_{\text{вл}}^u + m_{\text{вл}}^c)}{(m_c + m_{\text{вл}})} \tag{4}$$

Substituting in (3) $m_{\text{вл}}^c = m_{\text{вл}} - m_{\text{вл}}^c$ from (4) we obtain

$$S_m = S_m^u - S_m^{\text{цел}} + S_m^{\text{ост}}, \tag{5}$$

where

$$S_m^u = \frac{m_{\text{вл}}}{(m_c + m_{\text{вл}})}; S_m^{\text{цел}} = \frac{m_{\text{вл}}^c}{(m_c + m_{\text{вл}})}; S_m^{\text{ост}} = \frac{m_c^{\text{вл}}}{(m_c + m_{\text{вл}})}$$

The first term on the right-hand side of equation (4) characterizes the measured value of the mass fraction of water in a wet gas, the second - the selectivity of the sorbent, i.e., its ability to

selectively absorb water from the analyzed medium, and the third term - the completeness of the separation of water from dry gas.

The values of the molecular weight of water $M_{\text{вл}}$ and dry gas M_c without impurities for equation (33) can be found from the reference data for pure water $M_{\text{вл}}=M_{\text{вчд}}$ and pure gases $M_{\text{сi}}^0$. The value of the molecular weight of dry gas M_c , which is a complex gas mixture, can be calculated from the values of the molecular weight of the dry gas components according to the equation:

$$M_c = \sum_{i=1}^k S n_i \cdot M_{\text{сi}}^0. \quad (6)$$

Thus, based on equation (6), we find that the problem of measuring the moisture content by the gravimetric method requires finding the measured value of the moisture content, the completeness and selectivity of water separation, and the content of impurities in dry gas.

Measured value of moisture content. It is determined by weighing the cells and vessels after accumulating a sufficient amount of each component. In this case, hollow bodies are weighed and relatively small changes against the background of large mass values are determined. In this case, the measurements are associated with the accumulation of the required amount of the analyte, and therefore, as a rule, the initial and final weighing is performed over a long time interval.

Sorption and condensation cells and vessels are elements, the parameters of which largely determine the accuracy of moisture mass measurement. Therefore, below are the theoretical substantiation of their main dimensions.

The relative error in measuring the mass of sorbed water is determined by the expression

$$\delta m_{\text{вл}}^c = \frac{\Delta m_{\text{вл}}}{m_{\text{вл}}^c} = n \cdot \frac{\Delta_{\text{вчд}}}{m_{\text{вл}}^c}, \quad (7)$$

where $\Delta m_{\text{вл}}$ is the absolute error in measuring the mass of moisture; $\Delta_{\text{вчд}}$ - absolute weighing error; n - proportionality coefficient.

The mass of moisture released in the cell is determined from the material balance equation

$$m_{\text{вл}}^c = (S m_{\text{вч}} - S m_{\text{вчл}}) F_{\text{сч}} \omega \tau \rho \quad (8)$$

Substituting this expression in (38) and taking into account that $S m = 0,6 S n$ for air, we obtain an equation describing the dependence of the error in measuring the moisture mass on the cell parameters and the conditions of the experiment on moisture release

$$\delta m_{\text{вл}}^c = n \cdot \Delta_{\text{вчд}} \cdot [0,6(S n_{\text{вч}} - S n_{\text{вчл}})] F_{\text{сч}} \omega \tau \rho \quad (9)$$

Since the shape of the cell section does not affect the conditions of the sorption process, a circular section is accepted, as it is easier to manufacture and operate. It is known from the theory of mass transfer that an increase in the gas flow rate through the bed leads to an improvement in the conditions for mass transfer. This means that the cell diameter should be chosen as small as possible. The limitation in this case is the possibility of the appearance of a wall effect (breakthrough), which occurs when the ratio of the layer diameter to the equivalent grain diameter is less than 10, as well as dust entrainment, which becomes significant at flow velocities of more than 0.3 m/s. The industry produces sorbent with granules of two sizes. To reduce the cell diameter, a fine sorbent is more acceptable, for which an effective grain diameter of 0.7 mm is obtained below. In this case, the cell diameter must be at least 7 mm. For reliability, taking into account the irregularity of the particle size distribution, as well as the manufacturability of the cell, the cell diameter is taken as 14 mm in relation to the standard seamless thin-walled tube 14x0.3 made of steel grade Kh18N10T.

The value of the proportionality coefficient n in equation (9) depends on the applied weighing method and the influence of systematic and random sources of error.

The height of the sorption layer was found by the equation:

$$H = \frac{(\tau - \tau_0)}{K_u}, \quad (10)$$

$$\text{where } \tau = \frac{\rho_c}{K \cdot f} \int_0^{X_{II}} \frac{dx}{Y_1 - Y^*}; \quad (11)$$

$$K_{uu} = \frac{\rho_c \cdot F \cdot X_{II}}{\rho \cdot v_0 \cdot Y_1}. \quad (12)$$

On the right side of equation (11) ($Y_1 - Y^*$) is the driving force of the process, which, even for the lower value of the application range of the installation (3000 mln⁻¹), makes the value of the integrals, and therefore the loss of protective action time, negligible. In this case, equation (11) taking into account (12) will take the form:

$$H = \tau \frac{\rho \cdot v_0 \cdot Sm}{\rho_c \cdot F \cdot X_{II}} \quad (13)$$

The mass of water is determined as the sum of the values of the mass of condensed water m_{ei}^k and sorbed water m in the condensation mode

$$m_{\text{eal}} = m_{\text{ei}}^k + m_{\text{ei}}^c \quad (14)$$

or masses of moisture sorbed in both cells in the sorption mode

$$m_{\text{eal}} = m c_{\text{eal}} + m_{\text{eal}}^c \quad (15)$$

In both cases, we will find the mass of water as the difference between the cell mass values before and after passing the gas using the Bard weighing method [4], and as a container - condensation or sorption cells, similar to the corresponding working cells.

We write the initial equilibrium equation

$$m_{\text{a1}} - V_{\text{a1}} \rho_{\text{e1}} + m_{\text{cop}\delta 1} + m_{\text{ei}}^* + m'_{\text{r1}} - V'_{\text{r1}} \rho_{\text{b1}} = m_{\text{r1}} - V_{\text{r1}} \rho_{\text{e1}} + m_{\text{r1}} - V_{\text{r1}} \rho_{\text{b1}} \quad (16)$$

Subtracting term-by-term equation (17) from equation (18), after the necessary transformations, we obtain the equation for determining the mass of sorbed and condensed moisture:

$$m_{\text{ei}}^{c,k} = (m_{\text{r2}} - m_{\text{r1}}) + \sum_{i=1}^7 m_i^{c,k} \quad (17)$$

where $(m_{\text{r2}} - m_{\text{r1}})$ – is the difference between the masses of the weights taken during the final and initial balancing of the cell; $m_1^{c,k}$ – correction for deviation of the nominal mass of weights from the actual; $m_2^{c,k} = (m'_{\text{r2}} - m'_{\text{r1}})$ – correction for balance instability; $m_3^{c,k} = (V_{\text{a2}} - V_{\text{T2}} + V_{\text{r2}} - V'_{\text{r2}}) \rho_{\text{e2}} - (V_{\text{a1}} - V_{\text{T1}} + V_{\text{r1}} - V'_{\text{r1}}) \rho_{\text{e1}}$ – correction for the influence of aerostatic force; $m_4^{c,k} = (m_{\text{e1}}^* - m_{\text{e2}}^*)$ – correction for the change in air mass in the cell; $m_5^{c,k} = m_{\text{ei}}^*$ – correction for moisture penetration into the cell through leaks; $m_6^{c,k} = (m_{\text{cop}\delta 1} m_{\text{cop}\delta 2})$ – correction for sorbent removal from the cell; $m_7^{c,k} = (m_{\text{a1}} - m_{\text{a2}} - m_{\text{r2}} + m_{\text{r1}})$ – correction for the change in the mass of the weighed bodies.

The m_4^c value depends on the change in the density of the sorbent when it absorbs moisture. In this case, there is a change in the volume and, consequently, in the mass of the air contained in the cell between the initial and final weighing. In [3] the following dependence is given:

$$m_4^c = V_{\text{ei}}^* (\rho_{\text{e1}}^* - \rho_{\text{e2}}^*) - \nu \rho_{\text{e2}}^*, \quad (18)$$

where $\nu = x \cdot m_{\text{ei}}$

For a lump sorbent, which is used in this case, anhydron, the porosity of the layer can be found using any liquid that does not interact with the sorbent, for example, gasoline. In this case, the following equation is applicable for the calculation:

$$\varepsilon = \frac{V_{\text{жс}}}{V_{\text{np}}} \quad (19)$$

where V_{np} – is the volume of space occupied by the sorbent layer; $V_{жс}$ – the volume of liquid displaced by the sorbent.

We find the bulk density of the sorbent as the ratio of the mass of the sorbent to the volume of the space it occupies:

$$\rho_{copб} = \frac{m_{copб}}{V_{np}} \quad (20)$$

We find the internal volume of empty cells by the mass of water filling the cell. This cell calibration was carried out in two stages. The first was to find the arithmetic mean value of the mass of that cell $m_{я}^0$ from the data of several measurements, and then the value of the mass of the weights that balance the cell with water $m_{г}$ was determined. The following equation was used for the calculation:

$$V_{я}^* = \frac{\left[m_{г} \left(1 - \frac{\rho_{г}}{\rho_{г}} \right) - m_{я}^0 \right]}{\rho_{вод} - \rho_{г}} \quad (21)$$

Thus, we obtain the following equation for calculating the correction for the change in air mass in the sorption cell:

$$m_4^c = \frac{\left[V_{ся}^* - (m_{ся}^0) \varepsilon \right]}{(\rho_{г1}^* - \rho_{г2}^*) + x m_{г1}^c \rho_{г2}^*} \quad (22)$$

where $m_{ся}^0$ and $m_{ся}^*$ are quantities whose values are constant for each cell.

The ε and $\rho_{copб}$ values can be taken as constant characteristics for a given sorbent, subject to the maximum packing density. The values of $m_{ся}$ and $m_{г1}$ should be determined for each experiment.

The air density in the sorption cell with the sorbent is calculated by equation (50), taking the value of the partial pressure of water vapor to be zero, assuming the air in the cell is dry. In this case, the temperature and air pressure in the cell will be taken equal to the ambient one, since the processes in the cell are slow and there is enough time for equalization. In addition, it should be taken into account that the sorption cell for some time, when removed from the system, turns out to be open to the atmosphere.

The equation for calculating the correction for measuring the mass of air in the condensation cell is obtained on the basis of equation (26) with the addition of a term that takes into account the displacement of air from the cell by condensed moisture $V_{конд} \cdot \rho_{г2}^*$:

$$m_4^k = \left[V_{кя}^* - \frac{(m_{кя}^0 - m_{кя}) \varepsilon}{\rho_{copб}} \right] (\rho_{г1}^* - \rho_{г2}^*) + x m_{г1}^{k,c} \rho_{г2}^* - V_{конд} \cdot \rho_{г2}^* \quad (23)$$

The values of the mass of moisture sorbed in the condensation cell are found from the temperature of the cooling water, assuming that the gas enters the sorption cartridge of the cell saturated at this temperature. This assumption is legitimate, since the process of moisture release is slow and this time is sufficient to establish the equality of the temperatures of the cooling water and gas in the cell. In this case, $m_{г1}^k = Sm^{oxl} \cdot m_c$, where Sm^{oxl} is the mass fraction, of moisture in the gas in a state of saturation at the inlet to the sorption cartridge. Its value can be determined from tables of saturated water vapor.

The value of the volume of condensate $V_{конд}$ is found through the mass of condensed moisture $m_{г1}^k$ and its density:

$$V_{конд} = \frac{(m_{г1}^k - m_{г1}^{k,c})}{\rho_{вод}}$$

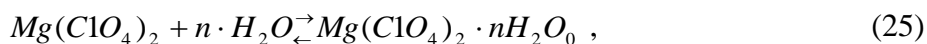
In this case, we obtain the equation for determining the correction for the change in air mass in the condensation cell:

$$m_4^k = \left[\frac{V_{кя}^* - (m_{кя}^0 - m_{кя})\varepsilon}{\rho_{сopб}} \right] (\rho_{\varepsilon 1}^* - \rho_{\varepsilon 2}^*) + \left[Sm^{oxl} \cdot m_c (\rho_{\varepsilon 0}^{-1} - x) - \frac{m_{\varepsilon l}^k}{\rho_{\varepsilon 0}^k} \right] \rho_{\varepsilon 2}^* \quad (24)$$

In this equation, the air density in the cell at the initial weighing $\rho_{\varepsilon 1}^*$ is determined by equation (25) with $p_{\varepsilon l} = 0$. Final weighing air density $\rho_{\varepsilon 2}^*$ is calculated using the same equation, but with a relative humidity of 50%. This is taken on the basis that most of the air in the cell is limited from below by condensate, from above by a layer of sorbent, and considering the humidity evenly distributed along the height of the air column. The gas pressure in the cell is equal to atmospheric pressure, since the cell is open for some time before and after the experiment. The air temperature in the cell is also taken equal to: the ambient air temperature, since the cell is kept for a sufficient time before each weighing to establish thermal equilibrium.

For equations (25, 26 and 27), we take $x = 0,819$.

This value is obtained as follows. According to [5] 1 gram-mole of anhydron can add 2; 4- or 6-gram moles of water:



where $n=2; 4$ or 6 .

During the dynamic process of sorption, i.e. when the gas flows through the sorbent, the formation of all three hydrated forms simultaneously is possible. Since the densities of all three forms are different, the changes in free volume are obviously equal, and, consequently, in the air mass in the cell. So, in [5] the following values of the density of anhydron and hexahydrate are given: 2.60 g/cm^3 and 1.970 g/cm^3 , respectively.

To determine the actual change in the volume of the sorbent, it is assumed that when 1 g of water is absorbed, the density of the formed hydrate lies between the density of pure hexahydrate and the density of pure dihydrate.

Substituting into equation (4.27) the corresponding values of molecular weights at $n=6$, we obtain: $223,23 \text{ g} + 6(18,016) \text{ g} = 331,33 \text{ g}$. This means that from 2.065 g of $Mg(ClO_4)_2$ upon absorption of 1 g of water, 3.065 g of hexahydrate is formed. The volume of 1 g of anhydron is $2.065/2.6=0.794 \text{ cm}^3$, the volume of the hexahydrate is $3.065/1.970=1.556 \text{ cm}^3$, i.e., each gram of sorbed water in this case changes the volume of the sorbent by 0.762 cm^3 .

Assuming the formation of only the dihydrate form from equation (28), we obtain that 6.195 g of $Mg(ClO_4)_2$, adding 1 g of water, forms 7.195 g of the dihydrate, and the volume of the sorbent will change from $6.195/2.60=2.383 \text{ cm}^3$ to $7.195/2.208=3.259 \text{ cm}^3$, i.e., by 0.876 cm^3 . Based on the assumption made, we find that the actual change in the volume of the sorbent will be $x=0.819 \text{ cm}^3/\text{g}$. Since, as shown above, about 0.6 g of water must be accumulated in the sorption cell to measure the mass with the required accuracy, the total change in free volume will be $V=0.5 \text{ cm}^3$, which corresponds to a change in air mass of $\sim 0.5 \text{ mg}$.

The $m_5^{c,k}$ value is determined by possible cell leaks. In this case, sources of leakage can be: insufficiently tightly sealed cell lids; openings during installation into the system and removal of cells from it; junction points between themselves and with the system; fittings not tightly closed with plugs.

All these components cannot be calculated and are determined experimentally. The methodology and results of the studies referred to hereinafter will be described below.

The value of $m_6^{c,k}$ is characterized by the dust entrainment of the sorbent, the flow rate and the filter density and can only be determined experimentally.

The value of $m_7^{c,k}$ in the limiting case is determined by changes in the cell mass due to hand contamination; dusting; contamination with gaskets; sorption-desorption of moisture on the outer surface.

The value of the fourth term for the sorption cell is calculated by the equation

$$m_7^c = K_c F \cdot \Delta S, \quad (26)$$

where F is the active surface, determined in the same way as in the case of dust; ΔS is a disturbing factor equal to the change in relative humidity during the time between the initial and final weighing; K_c - proportionality coefficient characterizing the sorption activity of the cell and container surface (determined experimentally).

For a condensation cell, which is in cooling water between the initial and final weighing, the correction for a change in its mass is determined by the completeness of drying of the surface of the working cell $m_{\text{ap}}^{\text{ocm}}$ and sorption effects on the surface of the container cell $m_{\text{am}}^{\text{c3}}$

$$m_7^k = m_{\text{ap}}^{\text{ocm}} - m_{\text{am}}^{\text{c3}}, \quad (27)$$

where $m_{\text{ap}}^{\text{ocm}}$ can be determined only experimentally, and $m_{\text{am}}^{\text{c3}}$ can be calculated by equation (28), taking the value of F equal to the value of the surface of only the container cell.

Conclusion. As noted above, several identical vessels were used to measure the mass of dry gas, therefore, the mass of dry gas is determined by the sum of their weight gain. Since all vessels have the same dimensions and mass, are made of the same material, and their surfaces are treated in the same way, we will consider the theoretical foundations for measuring the mass of dry gas using one vessel as an example. In this case, to simplify the notation, in the future, the symbol m_c will denote the mass of gas in one vessel.

It was substantiated and proposed to correct the readings of metering units using the product of coefficients reflecting the constancy of the composition, as the ratio of densities under standard conditions of actual and contractual compressibility.

In the gas density measurement method, the correction is carried out automatically during the measurement, in other methods it is absent, which leads to inaccurate measurements.

An algorithm for determining the limits of the absolute error of the measurement results of the supplier and consumers in real operating conditions and the determination of the amount of natural gas based on instrumental control is proposed.

References

1. Begunov, A.A. K voprosu o edinstve izmereniy v analitike. Part 1. Izmeryaemoe svoystvo. - Pishhevaya promishlennost (V pechati).
2. Vasilev V.P., Morozova R.P., Kochergina L.A. Praktikum po analiticheskoy ximii. Pod red. V. P. Vasileva. - M.: Ximiya, 2000. - 328 p.
3. Begunov, A.A. Pretsizionnie izmeritelnie yacheyki. CH. 1. Ustroystvo i metodika izmereniya j. «Metrologiya». 2016 № 3 p. 22-26.
4. Rudo N.M. Laboratornie vesi i tochnoe vzveshivanie. M.: Standartgiz, 1963, 150 p.
5. Korenman YA.I. Praktikum po analiticheskoy ximii. Analiz pishhevix produktov: V 4-x knigax. 2-e izd., pererab. i dop. Kniga 1 — M.: Kolos S, 2005. – 239p: il.
6. Aleksandrov V.S., Trunov N.N., Lobashev A.A. General problems of metrology and measurement technique: system approach to metrology of quantum multiparticle systems.