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New approaches to accounting petroleum and petroleum products in Ukraine

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Abstract

This paper analyzes the measures to increase the accuracy and reliability of accounting of petroleum and petroleum products in Ukraine on the basis of the mandatory equipment of excise petroleum products warehouses with level meter-counters and flow meter-counters.

For this purpose, the excise warehouses for the petroleum and petroleum products are equipped with level meters-counters and flow meter-counters with the transfer of information in automatic mode to the State fiscal service of Ukraine. The phased procedure for the introduction of automatic data transfer from excise warehouses is envisaged. In this case, the level meter-counter means a level meter, which measures the level, temperature and density and calculates, according to the strapping table of the storage tank entered into the memory of the level meter, the volume of petroleum and petroleum product, reduced to a temperature of 15 °C.

In accordance with current regulatory documents, the maximum permissible error of the level meter should be ± 2 mm for petroleum products and ± 3 mm for petroleum. The maximum permissible error for the flow meter-counter should be ± 0.25 %. At present, quite a lot of types of level meters are undergoing a conformity assessment with the technical regulations of legally regulated measuring instruments with the aim of using them as level meter-counters.

The important question is the error with which the level meter-counter determines the volume of petroleum and petroleum products in the storage tank and the allowable discrepancy between the results of volume measurement using the level meter-counter and flow meter-counter. The corresponding formulas for calculating these quantities are given.

Measurement methods and methods for calculating permissible imbalance need to be used.

The stated approach of operational control of accounting should be applied to other energy resources — in particular, to control the caloric content of natural gas.

Keywords: petroleum; petroleum product; storage tank; warehouse; level meter-counter.

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Introduction

Along with the need to ensure high accuracy of measurements in commercial operations with petroleum and petroleum products, an equally important task is to accurately measure the volume of petroleum and petroleum products in storage tanks at each time point ("residuals").

Results of research

Since January 1, 2018, the Resolution of the Cabinet of Ministers of Ukraine No. 891 of November 22, 2017 [1] on equipping excise warehouses of petroleum and petroleum products with level meter-counters and flow meter-counters came into force. The level meter-counters should not only measure the level of petroleum and petroleum products in storage tanks, but also, using a storage tank strapping table, measurement channels of temperature and density of petroleum and petroleum products entered into the memory of the level meter-counter, determine the volume of received and sold petroleum and petroleum products reduced to a temperature of 15 °C. Thus, the level meter performs the function of a volume counter reduced to a temperature of 15 °C. At the same time, the volume of received and sold petroleum and petroleum products is measured by a flow meter-counter (also reduced to a temperature of 15 °C). All current information is transmitted in real time in electronic form to a division of the State Fiscal Service.

The procedure for maintaining the Unified State Register provides for the following automatic data transfer: from June 1, 2018 — for excise warehouses with the storage tanks with a total capacity of more

than 20,000 m³; from January 1, 2019 — for excise warehouses with the storage tanks with a total capacity of 1,000 to 20,000 m³; from June 1, 2019 — for excise warehouses with the storage tanks with a total capacity of not more than 1000 m³. The required maximum permissible error of the level meter and the flow meter is determined by the current instruction for the accounting of petroleum and petroleum products (hereinafter referred to as the Instruction) [2] and for petroleum products is ± 2 mm, for petroleum — ± 3 mm. The maximum permissible error of a flow meter-counter, which realizes an indirect method of dynamic measurements, according to the Instruction and the current standard [3], should assure a measurement of the volume of petroleum and petroleum products reduced to a temperature of 15 °C, with an error of not more than ± 0.25 %.

A very important factor in ensuring the required accuracy of the volume of petroleum and petroleum products with a level gauge-counter is the timely receipt of storage tank strapping tables at their verification. The verification interval for storage tanks of 5 years is defined in [4], but it is not fully consistent with the requirements of the Instruction [2]. In the Instruction, the verification interval of 5 years is determined only for tanks, according to the data of which the receiving of the petroleum products was performed, for other tanks the verification interval is 10 years. In addition, the verification interval for tanks is currently not always performed.

No less important is the question of the error with which the level meter-counter determines the volume of petroleum and petroleum products in the tank, and what is the allowable discrepancy between the results of volume measurement using the level meter-counter and flow meter-counter. In [3], the error of mass measurement of petroleum and petroleum products was determined by an indirect method of static measurements ± 0.5 % for a mass of more than 100 tons (the error of mass measurement is slightly different from the error in volume measurement). However, the calculated expressions in this standard and other works show that these errors can vary significantly (up to several percent). Measurement procedures and procedures for calculating the permissible imbalance should be used. Such procedures can be developed on the basis of measurement procedures developed at NSC "Institute of Metrology" [5–9].

We present some results of calculations of measurement error and allowable imbalance.

The measurement equation for the volumetric difference V_{dif}, m³, of petroleum and petroleum products in the tank at the end and at the beginning of the reporting period:

$$V_{dif} = \left| V_{res\ 2} - V_{res\ 1} \right|, \quad (1)$$

where $V_{res\ 1}$ and $V_{res\ 2}$ — the volume of petroleum and petroleum products in the tank at the beginning and at the end of the reporting period, respectively, m³.

The same value, reduced to a temperature of 15 °C:

$$V_{dif\ 15} = \left| V_{res\ 15\text{-}2} - V_{res\ 15\text{-}1} \right|. \quad (2)$$

On the basis of expressions (1) and (2), the following calculated expressions are obtained.

The measurement error of the difference in mass and volume, reduced to a temperature of 15 °C, of petroleum and petroleum products in tanks at the end and at the beginning of the reporting period, using level meters-counters, based on the measurement method [6], is calculated by the following expressions. For vertical cylindrical tanks, the relative measurement error for difference in volume, reduced to a temperature of 15 °C, $\delta_{V\ tank\ 15}$, is:

$$\delta_{V_{tank\,15}} = \pm 1{,}1 \sqrt{\frac{1 + \frac{H_{max}^2}{H_{min}^2}}{\left(\frac{H_{max}}{H_{min}} - 1 \right)^2} \cdot \left(\delta_к^2 + \delta_н^2 + \delta_ρ^2 \right)}, \quad (3)$$

where H_{max} and H_{min} — the maximum and minimum level of petroleum products during the reporting period; δ_k, $\delta_н$ and $\delta_ρ$ — relative errors of strapping of the tank, level meter and densitometer,%, respectively.

In accordance with [10], δ_k for the nominal capacity of vertical tanks of more than 100 m³ is from ± 0.10 to ± 0.15 %. The value $\delta_ρ$ is taken, as a rule, for calculations equal to 0.1 %. The value $\delta_{V\ tank15}$ for vertical tanks does not exceed the value of ± 0.5 % normalized in [3] with a ratio

$$\frac{H_{max}}{H_{min}} \geq 2{,}2$$

for tank capacity from 1,000 to 3,000 m³,

$$\frac{H_{max}}{H_{min}} \geq 2$$

for a tank capacity of 4,000 m³ and

$$\frac{H_{max}}{H_{min}} \geq 1{,}7$$

for a tank capacity of 5,000 m³ or more.

For horizontal cylindrical tanks, including tanks at fuel filling stations, $\delta_{V\ tank15}$ is:

$$\delta_{V_{tank\,15}} = \pm \frac{1{,}1}{\left| 1 - \frac{V_{res\ 15-1}}{V_{res\ 15-2}} \right|} \cdot \sqrt{\left(\delta_к^2 + \delta_ρ^2 \right) \left(1 + \frac{V_{res\ 15-1}^2}{V_{res\ 15-2}^2} \right) + \left(\Delta_Н \cdot 100\ \% \right)^2 \cdot \left[\frac{V_{res\ 15-1}^2}{V_{res\ 15-2}^2} \cdot \left(\frac{\Delta^2 V_{res\,1}}{V^2_{res\,1}} + \frac{\Delta^2 V_{res\,2}}{V^2_{res\,2}} \right) \right]}, \quad (4)$$

where $V_{\text{res }15-1}$ and $V_{\text{res }15-2}$ – the volume of petroleum and petroleum products in the tank, reduced to a temperature of 15 °C, at the beginning and at the end of the commodity operation, respectively; Δ_H — absolute error of the level meter, mm; Δ_{Vres1} and Δ_{Vres2} – the volume of petroleum and petroleum products, which corresponds to 1 mm of the tank filling height, m^3/mm — capacity factor in the tank strapping table.

In the case of selling for the reporting period of petroleum and petroleum products through a volume counter, reduced to a temperature of 15 °C with a relative error δ_v, the maximum permissible deviation (due to counter errors and measurements in the tank) of the volume of petroleum and petroleum products in the tank from the volume obtained by the data of their selling using the counter, related to the nominal capacity of the tank $V_{\text{res nom }15}$, for a vertical tank (allowable imbalance) is:

$$\frac{\Delta V_{\text{dev }15}}{V_{\text{res nom }15}} = \pm 1{,}1 \cdot \sqrt{\delta'^{2}_{V_{15}} \cdot \frac{V'^{2}_{15}}{V_{\text{res nom }15}} + \frac{\left(V_{\text{res }15-1} - V_{\text{res }15-2}\right)^2}{V^2_{\text{res nom }15}} \cdot \frac{1 + \dfrac{H^2_{\max}}{H^2_{\min}}}{\left(\dfrac{H_{\max}}{H_{\min}} - 1\right)^2} \cdot \left(\delta^2_K + \delta^2_H\right)}.$$

Currently, quite a lot of types of level meters-counters are being passed conformity assessment or are being prepared to pass the conformity assessment to the technical regulations of legally regulated measuring instruments in order to use them as level meters-counters. Metrological tests of these level meters as part of module F and, partly, module B are planned to be held at NSC "Institute of Metrology" using the state primary (national) measurement standard of the length unit for the liquid level DETU 03-02-2015 with a measurement range of up to 20 m and an expanded uncertainty of 0.3 mm.

Such an approach to operational control of accounting should be applied to other energy resources, in particular, to control the caloric content of natural gas. The caloric content of natural gas in Ukraine varies within fairly wide limits (by tens of percent). For this reason, it is advisable to use instruments with an accuracy of (2–3)% to measure its calorific value at the nodal points of populated areas. They are less accurate than chromatographs, but cheaper and faster, with operation in automatic mode. The information obtained should be submitted continuously to the state body independent of the gas suppliers.

Conclusion

According to the Resolution of the Cabinet of Ministers of Ukraine No. 891, all storage tanks for petroleum and petroleum products of excise warehouses should be equipped with level meters with an error from ± 2 to ± 3 mm and volume counters with an accuracy of ± 0.25 %. Information on the volume of petroleum and petroleum products, reduced to a temperature of 15 °C, should be submitted electronically to the State Fiscal Service.

Нові підходи до обліку нафти та нафтопродуктів в Україні

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Анотація

Аналізуються заходи щодо підвищення точності та надійності обліку нафти та нафтопродуктів в Україні на основі впровадження обов'язкового оснащення акцизних складів нафтопродуктів рівнемірами-лічильниками та витратомірами-лічильниками.

З цією метою акцизні склади нафти та нафтопродуктів оснащуються рівнемірами-лічильниками та витратомірами-лічильниками із передаванням інформації в автоматичному режимі до Державної фіскальної служби України. Передбачається поетапний порядок впровадження автоматичного передавання даних з акцизних складів. При цьому під рівнеміром-лічильником розуміється рівнемір, який вимірює рівень, температуру та щільність нафти та нафтопродуктів і розраховує, за введеною у пам'ять рівнеміра градуювальною таблицею резервуара, об'єм нафти та нафтопродуктів, приведений до температури 15 °C.

Відповідно до діючих нормативно-правових документів, максимально допустима похибка рівнеміра повинна бути ± 2 мм для нафтопродуктів та ± 3 мм для нафти. Максимально допустима похибка для витратоміра-лічильника

повинна бути ± 0,25 %. На сьогодні достатньо багато типів рівнемірів проходять оцінку відповідності технічному регламенту законодавчо регульованих засобів вимірювальної техніки із метою їх використання як рівнемірів-лічильників.

Важливим є питання стосовно похибки, із якою рівнемір-лічильник визначає об'єм нафти та нафтопродукту в резервуарі, та яке допустиме розходження результатів вимірювання об'єму за допомогою рівнеміра-лічильника та витратоміра-лічильника. Наведені відповідні формули для розрахунку цих величин.

Повинні використовуватися методики вимірювань та методики розрахунку допустимого дисбалансу.

Викладений підхід оперативного контролю обліку варто застосовувати також для інших енергоресурсів — зокрема для контролю калорійності природного газу.

Ключові слова: нафта; нафтопродукт; резервуар; склад; рівнемір-лічильник.

Новые подходы к учету нефти и нефтепродуктов в Украине

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Аннотация

Анализируются меры по повышению точности и надежности учета нефти и нефтепродуктов в Украине на основе введения обязательного оснащения акцизных складов нефтепродуктов уровнемерами-счетчиками и расходомерами-счетчиками.

С этой целью акцизные склады нефти и нефтепродуктов оснащаются уровнемерами-счетчиками и расходомерами-счетчиками с передачей информации в автоматическом режиме в Государственную фискальную службу Украины. Предусматривается поэтапный порядок введения автоматической передачи данных с акцизных складов. При этом под уровнемером-счетчиком понимается уровнемер, который измеряет уровень, температуру и плотность нефти и нефтепродуктов и рассчитывает, по введенной в память уровнемера градуировочной таблице резервуара, объем нефти и нефтепродукта в резервуаре, приведенный к температуре 15 °С.

В соответствии с действующими нормативно-правовыми документами, максимально допускаемая погрешность уровнемера должна быть ± 2 мм для нефтепродуктов и ± 3 мм для нефти. Максимально допускаемая погрешность для расходомера-счетчика должна быть ± 0,25 %. В настоящее время достаточно много типов уровнемеров проходят оценку соответствия техническому регламенту законодательно регулируемых средств измерительной техники с целью их использования в качестве уровнемеров-счетчиков.

Важным является вопрос о погрешности, с которой уровнемер-счетчик определяет объем нефти и нефтепродукта в резервуаре, и какое допускаемое расхождение результатов измерения объема с помощью уровнемера-счетчика и расходомера-счетчика. Приведены соответствующие формулы для расчета этих величин.

Изложенный подход оперативного контроля учета следовало бы применять и для других энергоресурсов — в частности для контроля калорийности природного газа.

Ключевые слова: нефть; нефтепродукт; резервуар; склад; уровнемер-счетчик.

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