ERRORS OF MEASUREMENT OF THE CALORIFIC VALUE OF COMBUSTIBLE GASES IN A BOMB CALORIMETER

A. V. Inozemtsev, J. O. Inozemtsev, Yu. N. Matyushin, and A. B. Vorob'ev

N. N. Semenov Federal Research Center for Chemical Physics of the Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation

Abstract: The volumetric (specific) heat (energy) of combustion (volumetric calorific value — VCV) of natural combustible gases is an important, practically demanded value. An analysis was made of the sources of errors in the measurements of VCV according to the Russian state standard methods using a calorimeter for burning with a bomb. The contribution of the accuracy of the instruments used to measure the VCV is quantified. It is shown that the existing methods for measuring VCV do not take into account the calorimetric features of gaseous fuel combustion. A method is proposed for measuring the VCV of natural combustible gases that takes these features into account. Data are presented on the measurements of the VCV of the reference methane with an estimate of the error in the results obtained, confirming the effectiveness of the proposed method.

Keywords: higher volumetric heat of combustion; lower volumetric heat of combustion; natural gas; bomb calorimeter for burning, measurement procedure; temperature; pressure; measurement error

DOI: 10.30826/CE19120407

Acknowledgments

This work was financially supported by the subsidy allocated by the N. N. Semenov Federal Research Center for Chemical Physics of the Russian Academy of Sciences for the execution of the State Task on the topic No. 0082-2016-0011 "Fundamental studies of the processes of transformation of energy-containing materials and the development of scientific bases for controlling these processes" (State registration No. AAAA-A17-117040610346-5).

References

1. GOST 10062-75. 1975. Gazy prirodnye goryuchie. Metod opredeleniya udel'noy teploty sgoraniya [Natural combustible gases. Method for determining the specific heat of combustion]. Moscow: Standards Publs. 33 p.
2. GOST R 8.816-2013. 2014. Gaz prirodnyy. Ob"emnaya teplota sgoraniya. Metodika izmereniy s primeneniem kalorimetra szhiganiya s bomboy [State system for ensuring the uniformity of measurements. Natural gas. Volumetric heat (energy) of combustion. Method for measurements using the bomb calorimeter]. Moscow: Standartinform. 21 p.
3. GOST R 8.736-2011. 2013. Izmereniya pryamye mnogokratnye. Metody obrabotki rezul'tatov izmereniy. Osnovnye polozheniya [State system for ensuring the uniformity of measurements. Multiple direct measurements. Methods of processing the results of measurements. Key points]. Moscow: Standartinform. 19 p.
4. GOST R 8.789-2012. 2014. Kalorimetry szhiganiya s bomboy. Metody poverki [State system for ensuring the uniformity of measurements. The bomb calorimeters. Method of verification]. Moscow: Standartinform. 21 p.
5. GOST R 8.668-2009. 2010. Teplota (energiya) sgoraniya ob"emnaya prirodnogo gaza. Obshchie trebovaniya k metodam izmereniy [State system for ensuring the uniformity of measurements. Volumetric heat (energy) of combustion of natural gas. General requirements to methods of measurements]. Moscow: Standartinform. 7 p.
6. Inozemtsev, A. V., J. O. Inozemtsev, and A. B. Vorob'ev. 2018. Izmerenie teplot sgoraniya prirodnykh goryuchikh gazov v kalorimetre szhiganiya s bomboy [Measurement of the heats of combustion of natural combustible gases in the combustion bomb calorimeter]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 11(2):24–30.
7. Inozemtsev, A. V., J. O. Inozemtsev, Yu. N. Matyushin, and A. B. Vorob'ev. 23.04.2019. Sposob opredeleniya udel'noy ob"emnoy teploty sgoraniya goryuchego gaza [A method for determining the specific volumetric heat of combustion of a combustible gas]. Application to the Patent of Russian Federation No. 2019112244.
8. Inozemtsev, A. V., J. O. Inozemtsev, Yu. N. Matyushin, and A. B. Vorob'ev. 2018. Sposob opredeleniya udel'noy ob"emnoy teploty sgoraniya prirodnogo goryuchego gaza v kalorimetre i ustroystvo dlya zapolneniya kalorimetricheskoy bomby goryuchim gazom [A method for determining the specific volumetric heat of combustion of natural combustible gas in a calorimeter and a device for filling a calorimetric bomb with combustible gas]. Patent RU 2646445 C1.

Received October 28, 2019

Contributors

Inozemtsev Alexey V. (b. 1976) — research scientist, N. N. Semenov Federal Research Center for Chemical Physics of the Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; vectr1@yandex.ru

Inozemtsev Jaroslav O. (b. 1966) — senior research scientist, N. N. Semenov Federal Research Center for Chemical Physics of the Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; vectr1@yandex.ru

Matyushin Yury N. (b. 1940) — Doctor of Science in technology, head of laboratory, N. N. Semenov Federal Research Center for Chemical Physics of the Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; professor, National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), 31 Kashirskoe Sh., Moscow 115409, Russian Federation; ynm07@mail.ru

Vorob'ev Alexey B. (b. 1946) — Candidate of Science in technology, senior research scientist, N. N. Semenov Federal Research Center for Chemical Physics of the Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; vectr1@yandex.ru