CALORIMETRIC MEASUREMENT OF THE HEAT OF COMBUSTION OF COMPOSITE MATERIALS, PYROTECHNIC COMPOSITIONS, AND INDUSTRIAL AND DOMESTIC WASTE

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 quality of pyrotechnic products is controlled on the basis of calorimetric measurements of their heats of combustion in a calorimetric bomb. The accuracy of calorimetric data on the heats of combustion of substances is determined, to a large extent, by the relative measurement method — the matching of the conditions of the calibration experiment with reference benzoic acid and the test measurement. Documents regulate the measurement of the heats of combustion of compositions in bomb calorimeters, determine the layout of the reference benzoic acid and test samples, as well as the mode and test scheme. The disadvantage of the document is the violation of the conditions of the test method relativity — the need for the onset of a regular thermal regime in the experiment is not taken into account. It is shown that the duration of measurements of pyrotechnic samples exceeds the time of calibration experiments due to the duration of cooling of a large amount of solid end products of the reaction, which ultimately affects the correctness of the results obtained. In the work on simulators, the influence of the duration of the main period of the experiment on the process of heat transfer was experimentally demonstarated. The value of the error of the measurement result from the process of heat transfer in the bomb, associated with the duration of the main period of the experiment, was determined. A method for conducting an experiment with enhanced heat transfer of combustion products and a minimum duration is suggested. Technical improvement of calorimetric tests is recommended. The quality of pyrotechnic products is controlled on the basis of calorimetric measurements of their heats of combustion in a calorimetric bomb.

Keywords: bomb combustion calorimeter; waste; composite materials; pyrotechnic compositions; heat of combustion; measurement result error; duration of the main period

DOI: 10.30826/CE22150113

Figure Caption

A method of burning of pyrotechnic compositions to increase heat transfer from reaction products

Table Captions

Table 1 Thermal equivalent of a calorimeter with an "empty" bomb and a main experimental period of 600 s

Table 2 Thermal equivalent with a "heavy" crucible with a mass of 17.01 g and a main experimental period of 600 s

Table 3 Thermal equivalent of a calorimeter with an "empty" bomb and a main experimental period of 900 s

Table 4 Thermal equivalent with a "heavy" crucible with a mass of 17.01 g and a main experimental period of 900 s

Acknowledgments

Research was carried out at the expense of a subsidy allocated by the N. N. Semenov Federal Research Center for Chemical Physics of the Russian Academy of Sciences for the implementation of the State Task on the topic No. 0082-2019-0006 "Fundamental research of the transformation processes of energetic materials and the development of scientific bases for controlling these processes," State registration number AAAA-A21-121011990037-8.

References

1. Inozemtsev, A. V., Ya. O. Inozemtsev, Yu. N. Matyushin, and A. B. Vorob'ev. 2019. Bombovyy kalorimetr dlya izmereniya teplot sgoraniya gazov [Measurement of the heats of combustion of natural combustible gases in the combustion bomb calorimeter]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 12(4):65–69. doi: 10.30826/CE19120406.
2. Inozemtsev, A. V., Ya. O. Inozemtsev, Yu. N. Matyushin, and A. B. Vorob'ev. 2020. Bombovyy kalorimetr sgo-

raniya so staticheskoy obolochkoy [A static-bomb combustion calorimeter]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 13(4):122–127. doi: 10.30826/CE20130413.

3. 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.

Received December 20, 2021

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; 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