U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 2152

Urea

Combustion Calorimetric Standard

This Standard Reference Material (SRM) consists of twenty-five grams of commercially prepared high-purity urea. SRM 2152 is intended for use in checking the suitability of apparatus, analytical procedures, and calculations involved in oxygen-bomb calorimetry of substances containing more than 15 weight-percent nitrogen.

The certified value for the quantity of heat evolved by combustion of a sample of this material in an oxygen-bomb calorimeter is:

$$10.536 \pm 0.003 \text{ MJ/kg.}$$

The uncertainty of the certified value is two standard deviations of the mean.

The certified value is for the following reaction at 25 °C.

$$CH_4ON_2(c) + 1.5\ O_2(g) \rightarrow CO_2(g) + N_2(g) + 2\ H_2O(liq).$$

Bomb Conditions:

(1) The SRM must be crushed to a powder and dried for 24 hours at 85 °C. It may be stored at room temperature in a closed container. The dried material must be pressed into a pellet before placing in the bomb.

(2) The mass of sample, in grams, is equal to 7 times the volume of the bomb in liters.

(3) The mass of benzoic acid, used as an auxiliary for ignition, is 2.0 percent of the mass of sample.

(4) The mass of water in grams, initially placed in the bomb, is equal to 30 times the volume of the bomb in liters.

(5) The pelletized material is burned in a bomb of constant volume filled with pure oxygen at a pressure of 30 atmospheres measured at 25 °C.

Recommended Procedures:

(1) The ignition energy must be determined in a separate experiment.

(2) The quantity of nitric acid produced in the combustion is determined by titration of the bomb solution with standard alkali. The energy of decomposition of nitric acid into nitrogen (gas) and water (liquid) was taken as 59 kJ/mol. The energy contributed by combustion of benzoic acid was taken as 26.434 MJ/kg.

(3) The energy evolved by the actual bomb process, ΔU_B, must be corrected to that for the ideal process, ΔU_c°, by the method of Prosen [1], Hubbard, Scott, and Waddington [2], or Månsson and Hubbard [3]. For further information regarding procedures in the calibration of combustion bomb calorimeters, the discussions by Coops, Jessup, and Van Nes [4] and Mosselman and Churney [5] should be consulted.

The measurements were performed and analyzed in the Thermochemical Measurements and Standards Section by W.H. Johnson, under the technical direction of G.T. Armstrong.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by L.J. Kieffer and T.W. Mears.

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Gaithersburg, MD 20899

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

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References

[1] Prosen, E.J., Chapter 5, Experimental Thermochemistry, F.D. Rossini, Editor, (Interscience Publishers, Inc., New York, 1956).

[2] Hubbard, W.N., Scott, D.W., and Waddington, G., J. Phys. Chem. 58, 152 (1954).

[3] Månsson, M., and Hubbard, W.N., Chapter 5, Combustion Calorimetry, S. Sunner and M. Månsson, Editors, (Pergamon Press, New York, 1979).

[4] Coops, J., Jessup, R.S., and Van Nes, K., Chapter 3, Experimental Thermochemistry, F.D. Rossini, Editor, (Interscience Publishers, Inc., New York, 1956).

[5] Mosselman, C., and Churney, K.L., Chapter 3, Combustion Calorimetry, S. Sunner and M. Månsson, Editors, (Pergamon Press, New York, 1979).