A Fully Automated Adiabatic Calorimeter for Heat Capacity Measurement between 80 and 400 K

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Heat capacity is one of the fundamental thermodynamic properties of materials and is very important to many physical and chemical theoretical researches and engineering technology design concerned with materials. Adiabatic calorimetry is the most reliable technique to determine heat capacity and obtain thermodynamic functions of substances; hence much work on heat capacity measurements has been performed with adiabatic calorimetric instruments all over the world [1]. Research on adiabatic calorimetry has been conducted in our Thermochemistry Laboratory since 1960s and several adiabatic calorimetric apparatuses have been constructed workable in the temperature ranges of 4.2–90 K, 80–400 K, 70–580 K , 300–600 K and 400–1700 K [2-8], respectively. Traditional adiabatic calorimetric experiments have the disadvantages of complicated experimental procedures and large amounts of experimental data to be treated for obtaining high precision heat capacity values. Therefore, we reconstructed the most frequently used adiabatic calorimeter workable in the temperature range of 80–400 K and greatly simplified the experimental operation procedures by using modern computerized technology and controlling theory on the basis of our previous automated adiabatic calorimetric apparatuses.

This newly constructed calorimetric instrument has the advantages of compact data acquisition and process system, advanced intellectual level and powerful processing ability of the software, better stability of measurement, higher reliability of data acquisition. The hardware of the fully automated adiabatic calorimeter consisted of a Data Acquisition/Switch Unit, 34970A Agilent, a 7 1/2 Digit Nano Volt /Micro Ohm Meter, 34420A Agilent, and a P4 computer. The software was developed according to modern controlling theory. The adiabatic calorimeter was mainly consisted of a sample cell equipped with a miniature platinum resistance thermometer and an electric heater, two (inner and outer) adiabatic shields, two sets of six-junction chromel-copel (Ni-55%, Cu-45%) thermocouple piles and a high vacuum can. A Lake Shore 340 Temperature Controller and a set of differential thermocouples were used to control the adiabatic conditions between the cell and its surroundings. The reliability of the calorimeter was verified by measuring the heat capacities of synthetic sapphire (α-Al2O3), Standard Reference Material 720. The deviation of the data obtained by this calorimeter from those published by NIST [9] was within ±0.1 % in the temperature range from 80 to 400 K.

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