Is Commercial Combustion Calorimeter Parr-6200 Suitable for Highly Precise Scientific Measurements?

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A key problem in chemistry is to predict the feasibility of a chemical reaction with respect to a good yield of a product in a reasonable time. Knowledge of enthalpies of formation, $\Delta_f H_m^\circ$, is particularly important because they contribute to the relative thermodynamic stability of the species involved in a chemical reaction. The conventional method for measuring $\Delta_f H_m^\circ$ of stable species in the condensed state (solid or liquid) have been largely combustion bomb calorimetry. If the sample of compound of interest is placed in an atmosphere of oxygen inside of a thermally insulated container, which is immersed in a water bath, and ignited, the measured temperature rise of the water bath can be used to determine the energy and further converted into the enthalpy of the combustion reaction. The enthalpy of this reaction, $\Delta_r H_m^\circ$, is defined as the sum of enthalpies of formation of all products minus the sum of enthalpies of formation of all reagents.

As a rule the accuracy of measurements of the energy released in a calorimeter is required to be close to $\pm$ 0.01%. In order to reach such a precision, the commercial combustion calorimeters are usually modified in scientific laboratories towards stabilization of the temperature constancy in water bath as well as enhancement of the temperature resolution inside the insulated container. However, according specification, recent constructive developments of the commercially available combustion calorimeter Parr-6200 seem to meet requirements for using this device for highly precise scientific measurements. In order to test precision and accuracy of the commercial Parr-6200, a set of 5 substances: benzoic acid (cr); nicotinic acid (cr); 3-methoxybenzoic acid (cr); adamantine (cr); and paraffin oil (liq) has been measured in our lab using self-made static-bomb combustion calorimeter and the Parr-6200 simultaneously. Results of the test measurements have definitely revealed that accuracy close to $\pm$ 0.01% could be achieved with the commercial calorimeter, provided that weightings procedures are performed at the level of 0.00001 g for the sample and 0.01 for the water amount in the system.