Accelerating Rate Calorimetry (ARC) for Investigation of Thermal Hazard Potential and Thermal Runaway

Ekkehard Füglein

NETZSCH-Gerätebau GmbH, Wittelsbacherstraße 42, 95100 Selb, Germany

Keywords: hydrogen peroxide, ARC, thermal hazard screening, thermal runaway

Calorimetry is the science of measuring heat and heat transfer associated, for instance, with changes of state, chemical reactions or phase transitions under specified conditions. This very general definition implements that calorimeters are adapted and designed to specific measurement conditions according to the particular target of the measurement. This is why nowadays, a huge variety of calorimeters is commercially available such as combustion, reaction, titration, scanning or mixing calorimeters along with many others.

Accelerating Rate Calorimetry (ARC) is a method to study worst-case scenarios and thermal runaway reactions. In contrast to other caloric techniques such as reaction calorimetry, combustion calorimetry or Differential Scanning Calorimetry (DSC), ARC-type equipment allow for an adiabatic sample environment. Adiabaticity is essential in order to observe the most tremendous reaction progress possible. Decomposition reactions, which are of particular interest in this context, produce heat and pressure, since the reactions are usually strongly exothermic and are forming decomposition gases. The adiabatic sample environment is realized inside the ARC-type calorimeter via a set of heaters surrounding the sample compartment and via a smart temperature control regime. The first objective is to detect the temperature at which the self-decomposition of a sample or a sample mixture starts. The second objective is to avoid any exchange of heat between the sample and the surroundings once the exothermic decomposition reaction has started.

This work presents results of the thermal decomposition of hydrogen peroxide solutions. A scanning device was used in order to detect whether or not the sample has a thermal hazard potential and an ARC-type device was employed in order to carry out tests under adiabatic conditions.