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Review of the methods for SADT determination

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Abstract

The self-accelerating decomposition temperature (SADT) is an important parameter that characterizes the thermal safety of transportation of self-reactive substances. The United Nations "Recommendations on the Transport of Dangerous Goods" (TDG) defines this parameter as "the lowest temperature at which self-accelerating decomposition may occur with a substance in the packaging as used in transport" and suggests four test methods for determination: the United States SADT test (US SADT test), the Adiabatic storage test (AST), the Isothermal storage test (IST), and the Heat accumulation storage test (Dewar test, HAST).

The US SADT test represents a full-scale explosive experiment that is carried out for a specific commercial package.

The AST and IST are the lab-scale experimental methods. Calorimetric data obtained are plotted in a form of a Semenov diagram (heat release and heat loss rates versus temperature) followed by estimation of critical conditions of thermal explosion. The critical temperature is rounded to the next higher multiple of 5 °C and reported as SADT.

The HAST is a small-scale method that allows experimental determination of SADT for the DEWAR use. The procedure of SADT determination is the same as for the US SADT test. The SADT for a commercial package will be the same provided that certain similarity conditions are satisfied.

The SADT is the parameter of high practical profile. Therefore it is no wonder that a great many articles have been published that are focused on various methodological aspects of SADT determination (suffice it to mention the recent discussion on the applicability of the HAST to determining SADT for solid substances). Nevertheless there are still several serious problems that should be analyzed and resolved. Some of these problems are considered in this paper.

At first we present the brief survey of the recommended methods, which is aimed at revealing their features and limitations.

Then the problem of serious discrepancy between two definitions of SADT is discussed. One definition is the basis for the US SADT test and the HAST, another one is used when the AST and IST are applied. It is shown that this discrepancy may result in getting quite different and, in some cases, unsafe estimates of SADT.

The next problem under consideration is the applicability of the HAST for determination of SADT for solids. The results obtained allow the conclusion that this test, within certain limits, can be applied for solids provided that a specific scale-up procedure is used. To some extent these results sum-up the active discussion held in the Journal of Hazardous Materials.

The last part of the paper demonstrates how the kinetics-based simulation method helps in evaluation of SADT for those complex but practical cases (complex reactions, stack of packages, etc.) when neither of the methods recommended by TDG can be used.