Effective and Practical Tools for Screening Reactive Hazards

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ABSTRACT

Chemical reactivity can be viewed as a double-edged sword for the chemical industry. On the one hand, it allows materials to undergo desired reactions to form products under moderate temperature and pressure. On the other hand, a reactive hazard exists when changes in chemical structure have the potential to generate heat, energy and gaseous byproducts that cannot be safely absorbed by the immediate surroundings (1). If the rate of energy release is rapid enough and not adequately controlled, it may also lead to uncontrolled catastrophic incidents caused by polymerization, decomposition, oxidation-reduction (redox), acid-base reactions, or reactions with water.

The U.S. Chemical Safety and Hazard Investigation Board (CSB) examined 167 serious chemical incidents in the U.S.
from January 1980 to June 2001 that involved uncontrolled chemical reactions. These incidents resulted in 108 deaths and hundreds of millions of dollars in property damage. Furthermore, 24% of the incidents were caused by inadequate hazard identification, even though hazard information for over 90% of the incidents was available in publicly accessible literature (2).

Most mid-size and large companies have a reactive-hazard management program to assess potential reactive hazards during storage, transport and processing of reactants, intermediates and products. The recommended procedure for evaluating and quantifying reactive hazards, shown in Figure 1 (3), is slow and resource-intensive, and in-house tests are expensive and not practical. The use of appropriate screening tools, however, can assure higher levels of process safety and reduce the high costs of detailed hazard assessment.

Efficient screening techniques can be used to obtain the requisite data in a short period of time with minimum resources. Knowledge of chemistry can be applied to extend the data to systems for which data are unavailable. It is important that this information be available during the process design stage in order to develop a safer process.

This article presents several practical and efficient screening tools, and examples that demonstrate the effectiveness of using the tools separately and together. The following screening methods are discussed:

- New Jersey's Toxic Catastrophe Prevention Act (TCPA), a state regulation that focuses on a substance's functional groups to identify reactive hazards (4)
- The National Oceanic and Atmospheric Administration's (NOAA) Chemical Reactivity Worksheet, which has a large database of incompatible materials (5)
- "Bretherick

: Handbook of Reactive Hazards," which provides detailed information on reactive chemicals, including incident records (6)

- Material Safety Data Sheets (MSDSs), which can indicate such potential hazards as combustible liquid, explosive, flammable, organic peroxide, oxidizer, pyrophoric, unstable (reactive) or water-reactive.