AIChE Alliance
SAChE News
Safety and Chemical Engineering Education

Safety and Chemical Engineering Education - Fall 2009

Chemical Safety Board Recommends Changes in Undergraduate Curriculum

In December, 2009, the U. S. Chemical Safety and Hazard Investigation Board (CSB) completed the investigation of the T2 Laboratories, Inc. runaway reaction that killed four and injured 23 (http://www.csb.gov/assets/document/T2_Final_Copy_9_17_09.pdf). The injured included 28 people working at nearby businesses. The CSB found that although the owners of the company had baccalaureate degrees in chemical engineering and chemistry, they did not fully understand the reactive hazards of the process and were unaware of the potential consequences of a runaway reaction. The CSB investigation report recommends that the American Institute of Chemical Engineers and the Accreditation Board for Engineering and Technology work together "to add reactive hazard awareness to baccalaureate chemical engineering curricula requirements." There were no other recommendations to companies, industry or labor organizations, or regulatory agencies.

The T2 Incident Investigation Report includes brief summaries of four other runaway reaction incidents caused in part by not recognizing reactive hazards:

an explosion at Morton International, Patterson, New Jersey, April 8, 1998 (9 injured);

an explosion at Concept Sciences, Inc., Hanover Township, Pennsylvania, February 19, 1999 (5 killed, 6 injured);

a toxic vapor cloud release at MFG Chemical, Inc., Dalton, Georgia, April 12, 2004 (154 treated, 5 hospitalized); and

a flammable vapor release and explosion at Synthron, LLC, Morganton, North Carolina, January 31, 2006 (1 killed, 14 injured).

Following the incident at Morton International, the CSB studied 167 serious incidents in the United States between January, 1980, and June, 2001, that involved uncontrolled chemical reactivity (http://www.csb.gov/assets/document/ReactiveHazardInvestigationReport.pdf). Forty-eight of these incidents resulted in 108 fatalities. There were an average six injury related incidents per year resulting in five fatalities per year. Over half of the incidents involved chemicals not covered by OSHA Process Safety Management or EPA Risk Management Program. As a result, the CSB recommended that OHSA and EPA expand reactive hazard coverage under the regulations, but neither has fully implemented the recommendation. Continued monitoring by the CSB indicates that reactive material incidents, such as the T2 explosion, continue to occur.

In light of previous investigations and studies of reactive hazards by the CSB, the recommendation to include awareness of reactive hazards in the undergraduate curriculum might be interpreted as a need for broader knowledge of process safety across the profession.

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SAChE, or Safety and Chemical Engineering Education, is a project under the auspices of AIChE's Center for Chemical Process Safety (CCPS). SAChE's charter is to enhance the presentation of process safety in undergraduate education.

SAChE News is published twice annually by the Undergraduate Education Committee of the AIChE Center for Chemical Process Safety.

The opinions expressed in the articles contained in *SAChE News* are not necessarily the opinions of the Center for Chemical Process Safety or the American Institute of Chemical Engineers.

Articles related to any aspects of safety in the academic community are solicited from both the academic and industrial communities for publication in *SAChE News*. Material should be sent directly to the editor for consideration.

Undergraduate Education Committee

AIChE Design Problem Awards for the Application of Process Safety and Inherent Safety

Awards were presented November 8, 2009, Gaylord Opryland Hotel, 2009 AIChE Annual Meeting.

Safety & Health Division Awards for Inherent Safety

The Safety & Health Divisions Awards are granted to the teams or individuals who apply one or more of the following concepts of inherent safety in their designs: (a) design the plant for easier and effective maintainability, (b) design the plant with less waste, (c) design the plant with special features that demonstrate inherent safety, or (d) include design concepts regarding the entire life cycle.

Safety and Health Division Award - Ted Ventrone Award ($ 600)
Brian Ashenfelter
Trine University
Advisor: Majid Salim - salimm@trine.edu

Safety and Health Division Award – Ephraim Scheier and Walt Silowka Award ($ 600)
Jared Clark
Kristin Wallace
Afshan Samli
Oklahoma State University
Advisors: Jan Wagner - jan.wagner@okstate.edu and Rob Whiteley - rob.whiteley@okstate.edu

SAChE Awards

The SAChE Awards are presented to team and individuals for designs that apply appropriate principles of chemical process safety.

SAChE Individual Safety Award (Walt Howard SAChE Award for $ 200)
Brian Ashenfelter
Trine University
Advisor: Dr. Majid Salim - salimm@trine.edu

SAChE Team Safety Award (Jack Wehman SAChE Award for $ 300)
Rhiannon Quirk
James Sims
Elizabeth Wienslaw
Northeastern University
Advisor: Barry Satvat - b.satvat@neu.edu

SACHE Products for 2010

The SAChE educational resourses are availble on the SAChE website (http://www.sache.org). The SAChE representatives have their institution's userid and password required to download these resources.

Fire Protection Concepts

Reed Welker
University of Arkansas

This SAChE product introduces the fundamental concepts of fires including their extinguishment and control. This streaming video presentation consists of two parts:

Section 1: "Fundamentals of Fire Behavior" describes some of the fundamental characteristics of fires including basic definitions, the fire triangle, and reaction mechanisms. Examples of burning gases, liquids, and solids are discussed and demonstrated in addition to the difference between a premixed flame and a diffusion flame. The importance of turbulence and buoyancy is discussed along with their effects on the behavior and size of large fires. (30 minutes)

Section 2: "Fire Extinguishment and Control" describes the major aspects of fire protection systems. National Fire Protection Association fire classification is discussed. Passive and active methods of fire control are discussed. Passive methods include inventory reduction, replacement of flammable materials, separation of process areas from storage, diking and impoundment, and fireproofing of structures. Active methods include water for extinguishment and control, regular and high expansion foams, dry chemicals, vaporizing liquids, and inerting agents. Field tests demonstrating these methods are shown. (41 minutes)

Hyperlinks to streaming video sources are included in a word processing file to view the videos.

The Bhopal Disaster: A Case History

R. Willey
Northeastern University

This SAChE product summarizes the events that led to one of the most significant toxic releases that has occurred to date in the chemical process industry. This product focuses on the chemical processes involved and can best be used in a course devoted to process safety as well as in courses dealing with chemical kinetics (as an example of a runaway reaction) or related to mass transfer and atmospheric dispersion. This product includes three resources:

Bhopal SAChE (Adobe pdf file) includes many details of the accident scenario including descriptions of the plant (and its equipment and piping), background chemistry, and potential hazards along with detailed references.

Bhopal SAChE Presentation (PowerPoint) includes speaker notes and includes much of the material in the word document.

The video, "Unraveling Bhopal," describes Bhopal with many scenes of the city, plant, and accident scenario. This 16 minute video was produced by the Union Carbide Corporation and includes details of the accident and the subsequent Union Carbide investigation illustrating the details and complexities of an accident investigation. The video is available through streaming video in BhopalDescription.pdf.

Understanding Atmospheric Dispersion of Accidental Releases

R. Schneider
CCPS Staff

This SAChE product is a relatively short CCPS concept book that includes a basic description of the processes involved in accidental releases of chemicals and the resulting downwind concentrations of gases, vapors, and aerosols. It describes the complex physics of neutrally buoyant vapors, dense-vapors, high-momentum releases, boiling and evaporating liquids, multiphase flow, and aerosol releases.

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The focus of this document is not on the calculation methods, but on the physical problem descriptions. This information will give the reader an excellent background to understand the assumptions and results of dispersion analysis useful in developing emergency response plans or as a part of a process hazard analysis. The document is also a useful tool to assess methods to prevent or mitigate releases.

The material is intended only as a basic introduction to dispersion modeling and the interested reader is encouraged to consult the cited references for further information.

Process Safety Course Presentations

D. Crowl
Michigan Technological University
S. Mannan
Mary Kay O'Connor Process Safety Center, Texas A&M University

This SAChE product contains 31 PowerPoint presentations that were developed in conjunction with two process safety courses taught by the authors of this product at their respective institutions for over ten years. Although many of the presentations are tied to a specific textbook (Crowl and Louvar, *Chemical Process Safety, Fundamentals with Applications*, Prentice Hall, 2002), the presentations can be used for any safety course (with or without a textbook). Each presentation includes speaker notes. Topics include:

- Introduction
- Toxicology
- Industrial hygiene
- Source models
- Atmospheric dispersion models
- Fires and explosions
- Designs to prevent fires and explosions
- Introduction to relief systems
- Sizing reliefs
- Hazard identification
- Risk assessment
- Accident investigation

These PowerPoint presentations can be adapted to fit the needs of the instructor.

Safe Handling Practices: Methacrylic Acid

R. Willey
Northeastern University

This SAChE product introduces students to the hazards of handling acrylic monomers along with safe handling practices that are relevant for handling any monomer. Acrylic monomers have some unique challenges including being corrosive and combustible with the potential for unanticipated, uncontrolled exothermic runaway reactions. The product includes five files that give an excellent introduction for handling monomers:

- SAChE Product Introduction 2009: This describes the Rohm & Haas accident including a time line.
- Tank Car Video: This is a TV news report and and Rohm and Haas description of the tank car accident with methyacrylic acid that happened on July 22, 1988. (7 minutes)
- R&H Article: This is a description of an accident investigation method as applied to the Rohm & Haas accident.
- Acrylic Monomer Handling: This is a Rohm & Haas training presentation for safely handling of acrylic monomers. Although the presentation is for acrylic monomers, the seven principles described are generally applicable for handling any monomer.
- European Bulletin: A Safe Handling Manual for methacrylic acid developed in Europe.

Note that a MSDS (Material Safety Data Sheet) and International Safety Card (containing NIOSH safety information) are included for methacrylic acid; since this information can become stale, updated information (available on the web) should be obtained when this instructional material is used.

SACHE Student Safety Certificate Program

A Certificate of Safety Achievement is presented by SAChE and AIChE to students who demonstrate proficiency in process safety training modules developed for SAChE. The program allows students to receive recognition for their efforts provided they are members of AIChE. Student application for AIChE membership is available at http://www.aiche.org/students.
The following modules are presently included in the program:

Inherently Safer Design (Dennis Hendershot, CCPS Staff Consultant) (2009)
Provides information for understanding inherently safer design of chemical processes and plants.

Safety in the Process Industries (Dan Crowl, Michigan Technological University, 2008)
Video series that introduces the application of chemical process safety technology in an actual chemical facility.

Risk Assessment (Ralph W. Pike, Louisiana State University, 2008)

Runaway Reactions (Amy Theis, Fauske and Associates, 2008)

Chemical Reactivity Hazards (Robert Johnson, Unwin Co., 2008)
Web-based SAChE product that provides an overview of the basic understanding of chemical reactivity hazards; supplemented with selected issues of the *Process Safety Beacon* from the SAChE archive.

After students have completed a module, they must successfully complete an on-line questionnaire which is available at http://www.aiche.org/SAChE_Questions.aspx to receive recognition. Lists of students who successfully complete a module will be sent to their SACHE contact school or department in addition to companies who are supporting the program. The lists of student who have completed certificates in 2008 and 2009 are posted at http://sache.org/student_certificate/documents/Completed2009.pdf and http://sache.org/student_certificate/documents/Completed2009.pdf.

For further information, please contact Lowell Aplebaum (lowea@aiche.org).