AIChE Alliance
SAChE News
Safety and Chemical Engineering Education

Safety and Chemical Engineering Education - Fall 2010

2010 SAChE Faculty Workshop

Ken Cox, Rice University

Twentyone university faculty from across the country gathered at the ExxonMobil Baytown site last August to discuss process safety. The draw was the faculty workshop offered organized by SAChE to familiarize university professors with the challenges of process safety and present advice on how to tap into the resources SAChE offers in support of their efforts.

This year's workshop featured speakers representing industry, the Chemical Safety Board, CCPS, SAChE, and OSHA. The technical lectures included such important safety topics as inherently safer design, reactive hazards, human factor awareness, combustible dust, and pressure relief devices. Of special interest were the discussions about the resources available to university instructors including the materials provided by SAChE, the reports from the CSB, and textbook materials. Examples were given about how these materials can actually be implemented in safety training, whether offered as a stand-alone course or integrated into other courses. The workshop was capped by an overview and tour of the ExxonMobil Baytown complex.

By all measures, this year's workshop was a great success. Based on faculty feedback and our own observations, this was an exceptional workshop, with most of the participants ranking it as "excellent." This is a tradition we need to continue as we see an increased awareness of the need for universities to provide process safety training. The urgency of this is emphasized by recent changes in the ABET requirements. Since many faculty do not have a background in process safety and have never learned about the educational resources available, workshops such as these are invaluable.

Much credit for the success of this workshop goes to our ExxonMobil hosts who not only offered the use of their facilities, but also provided many of the speakers and gave a very educational plant overview and tour. We also thank all of the speakers who offered their time and insights to make this workshop such a beneficial experience.

Chicago, IL
March 13-16, 2011

http://www.aiche.org/Conferences/specialty/GCPS.aspx

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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 at the 2010 AIChE Annual Meeting.

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)
Ryan T. Gruell
Trine University
Advisor: Dr. Majid Salim - salimm@trine.edu

SAChE Team Safety Award (Jack Wehman SAChE Award for $ 300)
Jason Crater
Joseph Masucci
Lindsey Mathews
Northeastern University
Advisor: Ron Willey -r.willey@neu.edu

Safety & Health Division Awards for Inherent Safety

There were no Safety & Health Division Awards for the 2010 Student Contest Design Problem. None of the solutions had inherent safety features.

Editor's Note: The SAChE Student Safety Certificate Program includes a module on Inherently Safer Design. The modules include resources for self-study. Completion of an online questionnaire to receive recognition in the form of a certificate and posting to the roster of students who have completed a module is optional. The Program and modules are described in more detail on Page 6.

SAChE Chem-E-Car Safety Award

The best safety descriptions and practices. ($500 split among the team members)

Brian Bell
Alysia Watson
Ashley Angelo
David Homol
David Ginley
Leesha Blake
Ohio University

Additional SAChE Products for 2011

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.

Case History: A Batch Polystyrene Reactor Runaway

Ron Willey (Northeastern University)

This case history describes a runaway reaction that occurred in a batch reactor manufacturing polystyrene and emphasizes the importance of carefully analyzing and controlling exothermic reactions. Companies now use semi-batch reactors (or stepwise addition of reactants) for such highly exothermic reactions. When control is lost, the consequences can be catastrophic – in this case, a large fire due to an uncontrolled release of a flammable material.

The lessons learned include:

- use redundant process control equipment with audible alarms,
- use semi-automated discharge systems,
- maintain critical process control equipment,
- develop, manage, and test emergency procedures,
- understand the hazardous characteristics of exothermic reactions,
- semi-batch reactors should be used for highly exothermic reactions, and
- use the Dow Fire and Explosion Index to identify and eliminate potential design and operating problems.

This case history is in a PowerPoint format that includes notes. The presentation can be used in reactor kinetics or design courses.

Student access: The PowerPoint presentation is available to students through the site.

Layer of Protection Analysis - Introduction

Art M. Dowell (Chemical Process Safety Consultant and Rohm and Haas, retired)

Layer of Protection Analysis (LOPA) is a semi-quantitative tool for analyzing and assessing risk that has gained acceptance in the Chemical Processing Industries (CPI) and has risen to be one of the leading risk assessment techniques used for process safety studies. LOPA generally employs more rigor and science than what is encountered with qualitative risk assessments but is less demanding than a detailed Quantitative Risk Assessment (QRA).

LOPA uses simplified methods to characterize the consequences and estimate the frequencies in the risk assessment process. To lower the frequency of the undesired consequences, layers of protection can be added to a process including: inherent process safety; the basic process control system; safety instrumented functions; passive devices, such as dikes or blast walls; active devices such as relief valves; and human intervention. The primary purpose of LOPA is to determine whether there are sufficient layers of protection against a specific accident scenario.

This product discusses important LOPA concepts, such as, a) rules for independent protection layers (IPL), b) basic process control systems (BPCS), c) safety integrity levels (SIL), d) methods for calculating mitigated consequences, and e) advantages of LOPA. An example using LOPA on a distillation column is included. This product assumes that students are familiar with process hazards analysis (PHA) techniques such as HAZOP and is intended for undergraduate students (especially in design courses) and practicing engineers interested in using LOPA.

Student access: An introduction and references are available to students through the site.

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Safety Guidance for Design Projects

Bruce K. Vaughen (Cabot Corporation)

This SAChE Product provides guidance for engineering design teams to help them meet the process safety requirements of academe and industry. A design project road map is included to help design teams incorporate the elements of Process Safety Management (PSM) used in industry. Specific SAChE products and SAChE Safety Certificates are referred to in this road map.

This product includes a description of the T2 accident that was the genesis of an important CSB recommendation that AICHE and ABET work together to add reactive hazard awareness to undergraduate chemical engineering curricula. The product includes:

- An overview,
- A PowerPoint presentation discussing: background including T2; project design process (road map); available SACHE resources; and a summary that gives a historical perspective of this product, and
- Handouts that are used with the PowerPoint presentation.

Student access: All files are available to students logged into the site.

Dow Fire and Explosion Index (F&EI) and Chemical Exposure Index (CEI) Software

S. Mannan (Mary Kay O'Connor Process Safety Center)
W. Smades (Dow Chemical Company)

This product covers The Dow Fire and Explosion Index Hazards Classification Guide 7th edition and Chemical Exposure Index Guide developed by The Dow Chemical Company and published by AIChE. The program was developed as a collaborative effort between the Mary Kay O'Connor Process Safety Center, The Dow Chemical Company and the American Institute of Chemical Engineers (AIChE).

The F&EI is a quantitative hazard index. It is based on historical data as well as the energy potential of the materials under evaluation and the extent to which loss prevention practices are applied. F&EI helps engineers to be aware of the hazards in each process unit and facilitates decisions to reduce the severity and/or the probability of the potential incident.

The Chemical Exposure Index (CEI) provides a simple method of rating the acute health hazard to people in neighboring plants or communities due to chemical release incidents. The CEI system provides a method of **ranking one hazard relative to another**. The CEI is used:

- For conducting an initial Process Hazard Analysis (PHA),
- To identify recommendations to mitigate risks, and
- In Emergency Response Planning.

This product includes the programmed calculations for the Fire and Explosion Index and Dow Chemical Exposure Index. User input determines the penalties and credits used to calculate the Fire and Explosion Index. Dow CEI lets the user simulate six different and independent release scenarios (gas, liquid overfill, etc.) simultaneously. The results include the airborne quantity, Chemical Exposure Index, and Hazard Distance.

Instructions for installing the software are included in the startup file.

Student access: All files are available to students logged into the site.

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.

You must be logged in as a student to view Student Certificate Program files. Log in here to view these files. 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; see the list of students who have completed the certificate in 2008 (PDF), 2009 (PDF), 2010 (PDF), or 2011 (PDF) (or 2011 (Excel format)).

For further information, please contact June Lee (junel@aiche.org).

The following modules are presently included in the program:

Dust Explosion Control

Joe Louvar, Wayne State University, 2010

Introduces background for understanding and preventing dust explosions.

Introduction

Dust explosions have received a lot of attention in recent years from industry and the U.S. Chemical Safety Board (CSB). CSB has made recommendations that should help prevent dust explosions, and this certificate is based on these recommendations.

To obtain this certificate, students should study all of the below resources and then pass the online exam to successfully complete this Safety Certificate.

Inherently Safer Design

Dennis Hendershot, CCPS Staff Consultant, 2009

Provides information for understanding inherently safer design of chemical processes and plants.

Introduction

Inherently safer design has received a lot of attention in recent years from industry, environmental groups, and has even been discussed in the general public and mass media. As of the summer of 2009, the state of New Jersey requires a consideration of inherently safer design options for facilities covered by its Toxic Catastrophe Prevention Program (TCPP), and Contra Costa County, California (east San Francisco Bay area) requires a similar evaluation for facilities covered by its industrial safety ordinance. Bills have been introduced in the United States Congress requiring consideration of inherently safer design, both for safety and also for potential benefit in making chemical

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facilities less attractive targets for terrorist activity. As of the summer of 2009, these proposals had not passed in Congress, but legislation is again under consideration.

To obtain this certificate, students should study all of the below resources and then pass the online exam to successfully complete this Safety Certificate.

Safety in the Process Industries

Dan Crowl, Michigan Tech University, 2008

Video series that introduces the application of chemical process safety technology in an actual chemical facility.

Introduction

This video series entitled "Safety in the Chemical Process Industries" presents a strong introduction to the application of chemical process safety technology in an actual chemical facility. The video series is divided in roughly 30 minute segments with a total viewing time of 3.5 hours. Topics include:

- concept of corporate safety programs
- laboratory safety inspections
- personal protective equipment
- process area safety features and procedures
- DIERS methods for characterizing runaway reactions
- equipment and methods for characterizing flammable dusts and vapors
- informal and formal safety reviews

To obtain this certificate, students view the streaming video series and then download and study the Study Guide. After watching the videos and reading the Study Guide, students must pass the online exam to successfully complete this safety certificate.

Risk Assessment

Ralph W. Pike, Louisiana State University, 2008

Browser-based SAChE product that provides an overview of the methods used for risk assessment, management, and reduction with examples and exercises.

Introduction

Topics focus on the detection, prevention and mitigation of risks include:

- screening analysis techniques
- hazard and operability studies (HAZOPS)
- checklist reviews
- fault tree and event tree analysis
- preliminary hazards analysis
- chemical plume and dispersion analysis
- safety audit

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- Explosion and Fire Analysis
- What-if Analysis
- Assessment of Health Effects
- Failure Modes and Effects Analysis (FMEA)
- Quantified Risk Assessment

The course material prepares students in a senior-level design course to develop the information needed in plant design (e.g., a HAZOP on a process flow diagram) or provides background to topics discussed in a process safety course. This product was also designed for practicing engineers or chemists who will be involved with risk analyses. The course material emphasizes how the methods for risk assessment, management, and reduction are related and function together.

To obtain this certificate, study the Risk Assessment self-study course (2008 SAChE Product). This course is narrated (available by clicking on a text icon). The course is distributed in a zipped file to preserve the directory structure. After unzipping the file, start the course by pointing a browser to the file index1.html in the Risk Assessment folder. After studying the materials, students must pass the online exam to successfully complete the Safety Certificate.

Runaway Reactions

Amy Theis, Fauske and Associates, 2008

CSB video and SAChE products that demonstrate the potential hazards and methods for controlling runaway reactions.

Introduction

This SAChE Student Safety Certificate focuses on managing chemical reaction hazards, particularly runaway reactions. Chemical reactions are integral to the process industries, and it is critical that reactions be properly understood in order to handle them safely. Available resources for identifying potential runaway reactions are presented in this module as well as tools for sizing relief systems to safely control and contain these potential runaway reactions.

Three sources of information should be studied to successfully complete the test for this module:

- U.S. Chemical Safety and Hazard Investigation Board (CSB) safety video entitled "Reactive Hazards: Dangers of Uncontrolled Chemical Reactions", dated July 31, 2007 (available through the CSB website at http://www.csb.gov/videoroom/default.aspx? or YouTube at http://www.youtube.com/watch?v=sRuz9bzBrtY)
- SAChE Product "Rupture of a Nitroanaline Reactor" (2007) by Dr. Ronald Willey
- SAChE module "Runaway Reaction – Experimental Characterization and Vent Sizing" (2005) by Dr. Ron Darby.

To obtain this certificate, students study the information sources above and pass the online exam to successfully complete the Safety Certificate.

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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.

Introduction

Chemical Reactivity Hazards is a web-based SAChE module that shows how uncontrolled chemical reactions can lead to serious harm. Key concepts for avoiding unintended reactions and controlling intended reactions are discussed including:

- Three major incidents that show the potential consequences of uncontrolled reactions
- How chemical reactions get out of control, including consideration of reaction path, heat generation and removal, and people/property/environmental response
- Data and lab testing resources used to identify reactivity hazards
- Four approaches to making a facility inherently safer with respect to chemical reactivity hazards
- Strategies for designing facilities both to prevent and to mitigate uncontrolled chemical reactions.

An extensive Glossary and Bibliography are directly accessible from any page. This web-based instructional module contains about 100 pages.

To obtain this certificate, study the Chemical Reactivity Hazards self-study course (2005 SAChE Product). The course is accessed using a Word documentwith a link to the web-based course and login information. Process Safety Beacons from March 2003, August 2003, December 2004, March 2005, August 2005, January 2006, and July 2006 should also be studied. After studying the materials, students must pass the online exam to successfully complete the Safety Certificate.