SACHE News

CCPS CENTER FOR CHEMICAL PROCESS SAFETY
An AIChE Industry Technology Alliance

Safety and Chemical Engineering Education - Fall 2004

A Message from the SACHE Committee

20th Anniversary of the Bhopal Tragedy

This December will be the 20th anniversary of the methyl isocyanate gas release at Bhopal, India, which killed over 3,000 people and caused tens of thousands of injuries. In visits to engineering classes at several universities over the last year or so, I have asked students, ranging from incoming freshmen uncertain as to which branch of engineering they wanted to pursue to chemical engineering seniors and graduate students, if they knew about the Bhopal incident. I find that practically none of the younger students have ever heard of the incident – perhaps, not surprising, since it occurred before they were born, and they have not yet begun their engineering education. More disturbing is that many of the seniors, graduate students, and graduate engineers newly hired into industrial jobs have not heard of Bhopal either. In discussions with Dr. J. P. Gupta at the Indian Institute of Technology, Kanpur, Trevor Kletz, and others, I find that this experience is not at all unusual. We, as chemical engineering professionals, owe it to the victims of the Bhopal tragedy to do everything that we can to make sure that nothing like this ever happens again. We cannot do that if our young engineering graduates do not even remember the incident. Perhaps the quotation from George Santayana, "Those who do not remember the past are condemned to repeat it." is overused, but it is still true. Following my question to the students I met, I made sure they had some awareness of Bhopal, and of their own future responsibility as engineers to make sure they are doing everything they can to design and operate safe facilities, no matter what engineering discipline they ultimately choose.

It is really easy to give students an awareness of Bhopal and other chemical industry accidents. The 2003 SACHE Module "Mini Case Histories" includes a brief (14 PowerPoint slides) overview of Bhopal that will provide a basic understanding of the incident. More importantly, it can be used to make students aware of the responsibility of engineers in designing and operating safe plants, and the consequences of a failure to do so. The Mini Case History module also includes brief overviews of other events – Pasadena, Flixborough, Paterson, and others. We have used some of these in-house at Rohm and Haas – we have asked co-op students, summer interns, and young engineers to study the incidents and give presentations on what happened to safety meetings and seminars. The same approach could be taken in a university setting – have the students study the incidents and present them, giving students a chance to learn about the incident and also to practice an important professional skill – making technical presentations. SACHE also has a number of more extensive presentations which describe these and other incidents in greater depth.

2005 SACHE Workshop

Rohm and Haas Company has agreed to host the 2005 SACHE Workshop at its facilities in Bristol, Pennsylvania, in suburban Philadelphia. The workshop will be held in late September or early October 2005, and will include tours of laboratory facilities and manufacturing facilities – primarily emulsion and solution polymerization and polymer isolation facilities. Chilworth Technologies, Inc. of Princeton, NJ, has also agreed to make their hazard evaluation laboratory facilities, including reactive chemistry calorimetry and dust explosion testing equipment, available for the workshop. We are developing a program and specific agenda for the workshop, which will begin on a Sunday evening and last through Wednesday afternoon. This will be the first time that we have held a SACHE process safety workshop in the northeastern United States, and we hope a location that

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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

SACHE and Safety and Health Division Awards

SACHE Safety Awards

Walt Howard Individual Safety Design Award, $200

Seth Holderman Sheldon
University of Kansas
Contact: Dr. Colin Howat — cshowat@ku.edu

Jack Wehman Team Safety Design Award, $300

David Burke, Jamie Tribe, Timothy Leong
Northeastern University
Contact: Dr. Katherine Ziemer — kziemer@coe.neu.edu

Safety and Health Division Awards

Ted Ventrone Awards for Inherent Safety, $500

Individual

Scott Roberts
University of Kansas
Contact: Dr. Colin Howat — cshowat@ku.edu

Seth Holderman Sheldon
University of Kansas
Contact: Dr. Colin Howat — cshowat@ku.edu

Team

David Burke, Jamie Triba, Timothy Leong
Northeastern University
Contact: Dr. Katherine Ziemer — kziemer@coe.neu.edu

SACHE Products for 2004

The following SACHE educational resourses are availble to member universities through the SACHE website:

Consequence Modeling I: Liquids and Gases,
Chemical Transportation with Case Histories,
Improving Communication Skills,
Green Engineering Tutorial, and
Prevention and Suppression of Metal Packing Fires.

In addition to these modules, the CCPS book *Guidelines for Design Solutions for Process Equipment Failures* has been sent to SACHE member representatives.

Note: The *Consequence Modeling* module is described in the Spring 2004 Edition of *SACHE News*. The other products are summarized in the current issue.

Guidelines for Design Solutions for Process Equipment Failures

Center for Chemical Process Safety

While there is no "perfect" solution or absolute zero risk, engineering design can significantly reduce risk potential in the chemical process industries. In *Guidelines for Design Solutions to Process Equipment Failures*, industry experts offer their broad experience in identifying numerous solutions to the more common process equipment failures including inherent safer/passive, active, and procedural solutions, in decreasing order of robustness and reliability. The book challenges the engineer to identify opportunities for inherent and passive safety features early, and use a risk-based approach to process safety systems specification.

The book is organized into three basic sections: 1) a technique for making risk-based design decisions; 2) potential failure scenarios for 10 major processing equipment categories; and 3) two worked examples showing how the techniques can be applied. The equipment categories covered are: vessels, reactors, mass transfer equipment, fluid transfer equipment, solids-fluid separators, solids handling and processing equipment, and piping and piping components.

Prevention and Suppression of Metal Packing Fires

Mark Roberts
Texas A&M University

Metal structured packing fires represent a unique and poorly understood hazard. While a rare occurrence, the potential for capital damage and injury to personnel as a result of such fires is extremely high. Since metal is not often thought of as a combustible material, the risks associated with structured packing fires are magnified by a lack of appreciation and understanding of the risk of packing ignition involved in maintenance activities in an industrial separation tower.

This training module discusses the possible causes of metal structured packing fires and methods for preventing and suppressing metal fires taken from industrial experience. The module contains brief descriptions of actual incidents involving packing fires as well as questions intended for class discussion.

The module contains a Microsoft PowerPoint presentation with notes that would be appropriate for class presentation or independent study and a report on the topic. This training module is appropriate for a separations, process safety, or senior design class

Green Engineering Tutorial: Environmentally-Conscious Design of Chemical Processes

Hui Chen and David R. Shonnard

Green Engineering is defined as the design, commercialization, and use of processes and products that are feasible and economical while minimizing risk to human health and the environment. This tutorial contains a detailed description of a systematic methodology for the design of greener and more profitable chemical processes. Concepts and methods that are suited for both early design screening assessments as well as thorough evaluations of detailed designs are presented. A tutorial is included with step-by-step instructions on the use of computer software for environmentally-conscious design.

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Green Engineering

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The software also includes algorithms for flowsheet costing as well as multi-criteria decision making. A case study comparing production of maleic anhydride from either n-butane or benzene is used to illustrate concepts and application of the software.

This green engineering tutorial will benefit capstone design course instructors and students in chemical engineering, environmental engineering, pulp and paper science and engineering, and mineral processing. Computer programs used in the materials are available from David Shonnard at drshonna@mtu.edu.

Improving Communication Skills

Robert M. Bethea and Sarah A. Brown
Texas Tech University

This module is designed to supplement junior and senior chemical engineering courses in which written or oral reports about experiments or other assignments are integral components. Examples of the proper format and style of student written work are included throughout. The module contains four files: Read Me First (instructions for access and use), Outline (the resource guide), and two Appendices.

The Outline emphasizes accuracy and clarity; the effective use of audience analysis; proper organization of material to focus on the conclusion or objective; and format, mechanics, consistency, voice, and tone for all types of communications. Business and technical correspondence, resumes, and various types of written reports including in-text citations and bibliographies are included. Guidelines are given for memorandum and letter reports and for team reports.

Because of the process safety implications for unit operations laboratory courses and undergraduate and graduate research projects, the crafting of safe, efficient, and effective operating procedures is presented as a separate section. Operating information, including safe limits and consequences for exceeding safe limits, are included in an example.

The topic of visual aids to support oral presentations emphasizes clear, concise illustrations. The material on oral presentations is designed to focus on the bottom line or conclusions. The use of audience analysis is emphasized as are presentation styles, mechanics, and delivery.

The style handbook begins with an intensive review of the parts of speech and their uses. This material is followed by the basic rules of English grammar and is illustrated by several pages of common mistakes. The elements of style and the use of smooth transitions are emphasized.

Five sets of student exercises composed of material taken from old unit operations laboratory reports are included as Appendix 1. These exercises focus on punctuation, grammar, style, and editing. Corrected versions of the student exercises are included as Appendix 2 *which should not be distributed to students*.

Chemical Transportation with Case Histories

Ronald J. Willey
Northeastern University

This SACHE product evolved from a recognized need that chemical engineering students should have background in transportation of chemicals before entering an industrial position. The first section is devoted to a brief background related to transportation of chemicals by ship, rail, and truck. The last section is devoted to transportation accidents that have occurred in the chemical process industry. Transportation accidents are typically much less severe than many of the case histories presented by SACHE in the past; however, these accidents are quite common. It is not unusual to hear of a transportation accident involving chemicals once or twice a month in major cities. It is hoped that students who use this product will gain an appreciation for transportation of chemicals, and further, that they will understand the regulations and details involved in movement of chemicals from one point to another.

Message from SACHE

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is convenient to many university chemical engineering programs will be attractive to potential attendees. We hope to have more specific information available at the Fall AIChE Meeting in Austin, Texas.

SACHE Activities at Fall 2005 AIChE Annual Meeting in Austin

In lieu of the traditional SACHE breakfast at the Annual Meeting, we will have a booth in the Exhibit Hall in the Conference Center. The booth will be open on Tuesday night, November 8th, from 4:30 to 7:30 PM. Refreshments will be served. Please visit us and share your ideas on how SACHE can continue with its mission of improving the knowledge and, more importantly, the safety culture of our chemical engineering students.

SACHE Website

Thanks to the efforts of Tom Spicer and his colleagues at the University of Arkansas, the SACHE website (www.sache.org) is up and running, and electronic versions of many of the 2003 and 2004 SACHE products are available for download. For 2004, you can download the following products: Consequence Modeling Source Models I: Liquids & Gases; Fundamentals of Chemical Transportation with Case Histories; Green Engineering Tutorial; Improving Communication Skills; Metal Structured Packing Fires; and University Access to SuperChems and ioXpress. Several 2003 products are also available from the web site: Mini-Case Histories; Safety Valves: Practical Design Practices for Relief Valve Sizing; and Safety, Health, and Environmental Text for Textbooks. Please visit the SACHE website and check out these products if you have not already done so. You should have received access information from SACHE – if you have not, please contact Karen Person at AIChE (karep@aiche.org).

At the SACHE website, you can also find a number of presentations and other links submitted by faculty members and industrial SACHE committee members which are available to anybody without charge – whether SACHE members or not (http://www.sache.org/links.asp). If you have developed any material which you believe would be useful to others teaching process safety to chemical engineers, please submit it to the SACHE webmaster using the link provided on the SACHE "Links" page. Currently the "Links" page contains a number of useful Powerpoint presentations submitted by Ralph Pike from LSU on various process safety topics, and laboratory and safety course material from Dan Crowl at Michigan Tech.

Always Looking for More Help

The SACHE Committee is always looking for ideas for how we can improve our products, and for new activities to further our mission of enhancing process safety education. If you are interested in joining the SACHE Committee, please contact Dennis Hendershot or Joe Louvar. Most of our meetings are by teleconference (a half day every couple of months) so participation is easy and does not require extensive travel.

Dennis C. Hendershot
Rohm and Haas Company
SACHE Committee Chair

Bob Rosen
BASF, retired
SACHE Committee Co-Chair

EPA Case Study: Phenol-Formaldehyde Reaction Hazards

A USEPA Chemical Safety Case Study of the September 10, 1997, Georgia-Pacific Resins, Inc. in Columbus, Ohio, is available at http://yosemite.epa.gov/oswer/ceppoweb.nsf/vwResourcesByFilename/gpcasstd.pdf/$File/gpcasstd.pdf. The explosion of an 8,000 gallon reactor resulted in the death of one operator and injury to four others. The incident investigation revealed that failure to follow standard operating procedures led to a runaway reaction. Under the runaway conditions, the emergency relief system was inadequate . Overpressure of the reactor resulted in an explosion that separated the top of the reactor from the shell.

With the "Lessons Learned" and "Steps to Reduce Hazards," this short (6 pages) case study could serve as an excellent resource for introducing many issues of chemical process safety in several chemical engineering courses - reactor design, laboratory, process design, and safety and environment.