

# SACHE News



## Safety and Chemical Engineering Education - Fall 2003

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### Status of SACHE

Dennis Hendershot, Chair  
CCPS Undergraduate Education Committee

### PRODUCT DISTRIBUTION

By now, you should have received the following SACHE products as a “hard copy” distribution:

- The Hazards of Hydroxylamine – A Case Study of the Explosion at Concept Sciences
- Mini Case Histories for Safety, Health and Environment
- The CCPS book *Understanding Explosions* by Dan Crowl

The following additional products will be available electronically to SACHE members through the new SACHE web site:

- Safety Valves: Practical Design Practices for Relief Valve Sizing
- SHE Text for Textbooks

You will be provided with the information on how to access the material on the SACHE web site as soon as it is ready for use.

### SACHE Web Site

Thanks to the efforts of Tom Spicer at the University of Arkansas, a new SACHE web site is being set up to better facilitate information transfer and allow electronic distribution of future SACHE products. For the past couple of years, all or nearly all products have been sent to SACHE member universities as both a hard copy and with an enclosed CD containing the material. This represents a significant cost to SACHE in terms of storing,

handling, and shipping the hard copy products. Many of our members have indicated that they would prefer to have the materials available electronically from a SACHE web site, avoiding the need to store and keep track of the hard copy products. We plan on distributing future products electronically via the SACHE web site, so you will be able to download them when you want them, rather than having to locate a binder with the hard copy and CD product. You will also be able to review the available materials and select relevant information to fit the content of a specific course.

Thanks to the University of Arkansas, especially Tom Spicer, for providing this service to SACHE. Our plan is to start with a simple web site, and grow its capabilities as we identify information and resources useful to SACHE members.

### 2003 Workshop at ExxonMobil

The 2003 SACHE Workshop was held in September 28 through October 1, 2003, at the ExxonMobil refinery and chemical complex in Baton Rouge, Louisiana. Twenty-three faculty members, representing 19 universities, attended the workshop. Scott Ostrowski of ExxonMobil and Ralph Pike of LSU did a wonderful job of setting up a valuable program, arranging for a good mix of facility tours and lectures/workshops by industry experts, and setting up physical arrangements for the workshop. Thanks in particular to Max Hohenberger, Clint Rabalais, Peter Lazar, Bob Baker, Lynne Pennison, Ray Comingore, Matthew Aguiar, David Harned, Dave Libbers, Hugh Helferty, Mike West, Gary Baudouin, Ron Mire, Guy Tremblay, and Ray French of ExxonMobil for their efforts in sponsoring the workshop, organizing and giving tours of the facilities, and generally providing valuable insight on the operations of their facilities.

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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 two times annually by the Undergraduate Education Committee of the AIChE Center for Chemical Process Safety. All original material is copyrighted by the AIChE Center for Chemical Process Safety.

The opinions expressed in the articles contained in the *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.

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## SACHE and Safety and Health Division Awards

### SACHE Safety Awards

Amber Rudy  
University of Missouri at Columbia

Walt Howard Individual Safety Design Award, \$200

Ellen Brennen  
Kevin Cash  
Jeffrey Pierce  
Northeastern University

Jack Wehman Team Safety Design Award, \$300

### Safety and Health Division Awards

Ellen Brennen  
Kevin Cash  
Jeffrey Pierce  
Northeastern University

Application of principles of inherent safety, \$500

Steve Dupuis  
Tom Sanders  
Wayne State University

Application of principles of inherent safety, \$500

Kristin Burford  
Rebecca Hoffmann  
Washington University

Application of principles of inherent safety, \$500

Joshua Jondro  
Joshua Grilly  
Nichole Winters  
Northeastern University

Application of principles of inherent safety, \$500

### SACHE Essay Awards

Chandler Benton  
Michigan Technological University

Reactive chemistry, \$500

Jeremy Pelt  
Wayne State University

Reactive chemistry, \$500

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## SACHE News Distributed Electronically

Beginning with the current edition, *SACHE News* will be distributed electronically in PDF format. This move will save the costs of printing and shipping, and permit the CCPS Undergraduate Education Committee to direct a larger portion of the shrinking budget to providing products and services to the SACHE member universities.

As the new SACHE Web Site evolves, SACHE members and CCPS sponsors will be added to a list server to facilitate delivery of SACHE News and other information. Anticipated benefits are wider access to, and more timely delivery of, SACHE products and information.

EDITORS NOTE: This is the first of two winning entries in the 2003 SACHE Student Essay contest. The second essay by Jeremy Pelt, Wayne State University, will be published in the Spring, 2004, issue of *SACHE News*. Each student will receive a \$500 award and a certificate at the AIChE Annual Meeting in San Francisco.

## Learning About Chemical Reactivity and Safety

Chandler Benton  
Michigan Technological University

During the summer and fall of 2001, I was on co-op at a pigment manufacturer in Lower Michigan. I was a process engineer, and as such worked frequently out in the plant. During the first half of my co-op term I worked to investigate a new technology application to improve the detection of a reaction endpoint. In order for me to be able to complete this project, I first had to learn and understand the process. This reaction produced an intermediate product that was used in another area of the plant to produce a final product. I learned what reaction was occurring, how the process worked, and some of the safety concerns involved with the reaction. It was known that if the temperature of the batch was not below a certain level, various side reactions would occur and the results could be very dangerous. One of the possibilities was the release of  $\text{NO}_x$  gases. Also the order the reactants are added into the bath is critical. If one is added out of order or forgotten this could result in an accident.

After I had been working there a couple of months, a release incident occurred. My friend and I were at home, and the area dispatcher broke in on the TV to alert the public of a chemical release at our plant. We both wondered what had happened, but had to wait until the next day at work to find out. It turns out the plant had a  $\text{NO}_x$  release and the vapor cloud drifted off site and towards the surrounding neighborhoods. Although this was a "minor" release, it was still handled very seriously. After an investigation, the cause was determined to be operator error. The operator did not have the batch at the proper temperature and this led to the release of the  $\text{NO}_x$  gases. It was also discovered the reason the temperature was not correctly maintained was because the operator was running two batches simultaneously and lost track of what actually was in the reactor. A reaction such as the one being used is one that needs to be treated

very carefully, and unfortunately this was not the case for this incident.

This was bad not only for the environment, but also for the public reputation of the plant. When the public sees things like this, they tend to not like having a chemical plant in their neighborhood. Avoiding these types of incidents helps not only to keep everyone safe, but keeps the company in a positive light in the community.

As a result of the release, the company was fined by MiOSHA and required to complete a hazardous operations review, or HAZOP. Since I had become familiar with the process and was working towards generating a training manual, I was asked to be a part of the review. Although I did not have the degree of knowledge as some of the other engineers, I was very familiar with the procedures the operators followed. Since this was a case of a standard operating procedure not being followed, my knowledge was useful. We went through the entire process and had to think of all the possibilities, such as the order chemicals were added, if a step was forgotten, or if too much was added, and evaluate the safety concerns with each step. This was a very long and tedious process, however we were able to identify a long list of issues relating to safety that needed to be addressed. Some of the solutions ranged from simple training, or not having operators run two batches at a time, all the way up to control system changes and physical changes to the plant set-up. One step which was immediately implemented was a chemist had to observe the raw material charges and confirm the correct amounts were added and in the correct order. This is not the ideal solution, however, training and other more permanent solutions were being worked on. It was important for the process to be evaluated with the goal being to reduce the possibility of another accident occurring in the future.

Completing the HAZOP illustrated the importance of industrial safety. As a large chemical plant, it is imperative for safety to have the utmost importance for all involved, including the community. Having standard operating procedures to make sure every operator is following the EXACT same procedure when making a batch is very important. At all times the operator should know what is or isn't in the reactor. In this case it also would have helped to have the operator only doing one batch at a time instead of two. If it is desired to make two batches, then there should be two operators. Otherwise, this is just asking for trouble. The operator can get overworked

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## Chemical Reactivity and Safety

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and easily forget what has been added to which batch. The plant needs to be a responsible corporate citizen and look out for the safety of all the employees, as well as community members.

This benefits my university experience in that I have a greater appreciation for chemical safety. I learned it is important to know what can happen in a reactor and how to prevent it. Not to mention the fact that you should ALWAYS know what is in the reactor, if you're not sure don't guess, it could be extremely dangerous if you do. Standard operating procedures are a must for any reaction to ensure everyone is following the same procedure when making a batch. This helps to make sure an operator doing their own thing does not cause variations in the process. I also learned not to overwork, or give too much work to an operator. This can result in problems as it did in this case. Better to be a little behind and be safe than to try to rush and cause an accident. Of course, dangers are always present at any chemical plant, but through strong plant safety programs these dangers can be reduced. Plant safety is something with which every worker at a plant should be concerned and should be involved with daily.

## Website on Reactive Chemistry Hazards

The *Thematic Network for Hazard Assessment of Highly Reactive Systems*, or *HarsNet* was initiated in 1998 by a group of 31 partners to provide a forum for universities, research centers, and industries to cooperatively develop and disseminate fundamental knowledge that can be used for hazard assessment of reactive systems. Subsequently, additional partners have joined.

One of the main purposes is to provide small and medium sized enterprises with the best available advice for assessing and controlling the hazards of exothermic reactions. As a result, several project tasks have been developed, each related to a different aspect of chemical safety. They include a book describing the best methods currently available for predicting, assessing, and minimizing exothermic reaction hazards; a methodology for hazard assessment of chemical processes; critical reviews of chemical safety training courses offered in Europe; a collection of links to chemical reaction safety related data; promotion of research to support proposed methodologies; and support of the interface between the *HarsNet* partners and small and medium sized enterprises. All of the resources are available on the *HarsNet* web site (<http://www.harsnet.de/>).

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## **Bhopal and It's Effects on Process Safety**

### **International Conference on the 20th Anniversary of the Bhopal Gas Tragedy**

at  
**Indian Institute of Technology, Kanpur, India**  
**December 1 to 3, 2004**

*Conference Announcement and Call for Papers*

<http://www.iitk.ac.in/infocell/announce/bhopal/>

Post conference tour of Bhopal for those interested  
Site-seeing tours of famous places in India

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## New SACHE Modules

These SACHE products are included in the 2003 SACHE educational resources distributed to member universities. Faculty and students should contact their SACHE representative for access to these and other SACHE products, including slide and PowerPoint presentations, videos, problem sets, NIOSH publications, and CCPS books. Recent SACHE deliverables are posted at <http://www.aiche.org/sache/sachedel.htm>.

### Mini-Case Histories

Joe Louvar  
Wayne State University

This product emphasizes learning from history or being doomed to repeat it. It includes three sections: a) Mini-Case Histories, b) Process Safety Beacon, and c) Safety Concepts as described below:

- a) Mini-Case Histories: There are eight PowerPoint presentations, with notes, that cover the accidents at Bhopal, Monsanto, Phillips, Flixborough, Morton, Tosco, Hickson, and Sonat. The root causes of each accident are included, such as, poor designs, lack of training, and poor management. The information summarized in these case histories was taken from SACHE products, and reports by the Chemical Safety Board.
- b) Process Safety Beacon: The Center for Chemical Process Safety is publishing monthly, one-page case histories or lessons learned. They are available on the Internet via CCPS Beacon. A few of the Beacons are included in this product to remind readers that these lessons are available.
- c) Safety Concepts: This product includes six PowerPoint presentations: i) Relief Valves, ii) Prevent Runaway Reactions, iii) Manage Design, Construction, and Operations, iv) BLEVEs, v) Explosions, and vi) Prevent Explosions. The concepts covered are those that are especially relevant to chemical plant accidents.

The Mini-Case Histories and Safety Concepts are deliberately developed in a PowerPoint format to give the users the opportunity to add slides or lessons concerning their own interest.

### Safety Valves: Practical Design Practices for Relief Valve Sizing

Eric N. Parvin and Arthur M. Sterling  
Louisiana State University

The goal of this module is to inform and educate inexperienced engineers about process safety management in general, and about safety valve sizing and the application of engineering principles to safe process design in particular. We also hope to encourage logical thinking patterns in an overview of process design for inherently safer process systems. The target audience will normally be college engineering students, but may also be entry-level engineers (0-3 years) who have not yet been exposed to this subject matter, or as a refresher for more experienced engineers.

Contained within this package are two software files (one MS PowerPoint presentation and one MS Excel file). The PowerPoint presentation is intended for educational purposes to gain knowledge and a general understanding of Process Safety Management. It is intended to take about one hour to present the material, but can be shortened (see "instruction" slide for further details). The Excel file contains several practical exercises for the students to work in a recitation-type environment, preferably in groups of two or three students. The Excel file contains the problems, solutions, and instructions to prepare the handouts for the class. The recitation is expected to take at least 1½ hours.

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## SACHE Modules

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### Safety, Health, and Environmental Text for Textbooks

Joe Louvar  
Wayne State University

SACHE's objectives are to a) assist professors to add safety, health, and environmental (SHE) concepts to the core courses of all chemical engineering departments, b) assist professionals to appreciate the importance of SHE concepts in university and company environments, and c) ultimately to help companies to improve their safety and environmental performance.

The genesis of this product was at a Faculty Workshop where a group of professors made the following remark: "The best way for professors to add SHE concepts to their courses is to have these materials in their textbooks." This product, consequently, was developed to help authors to add safety, health, and environmental concepts to their textbooks. The subjects addressed include: a) Kinetics, b) Thermodynamics, c) Stoichiometry, d) Mass Transport, e) Heat Transport, and f) Design.

This product has three major sections: a) Text with Examples to embed into the chapters of textbooks, b) Problems and Solutions for the end of the chapters, and c) SHE related figures that can be added anywhere within textbooks and/or for enhancing lectures. The materials were primarily adapted from existing SACHE products. These materials can be easily cut and pasted into an author's document.

### Accra Pac Group Ethylene Oxide Explosion Investigation Report

The United States Environmental Protection Agency has investigated an explosion and fire that occurred at the Accra Pac Group, Inc., North Plant Facility located in Elkhart, Indiana, on June 24, 1997. The incident killed one employee, injured 59 others, and resulted in the evacuation of a one-mile radius from the facility.

This Accra Pac facility produces pressurized containers, mostly consumer aerosol products such as hair sprays and deodorants.

This new CCPS book is included in the 2003 SACHE products distributed to member universities.

### Understanding Explosions

Daniel A. Crowl  
Michigan Technological University

There are many different types of explosions, each with its own complex mechanism. Understanding explosions is important in preventing them. This reference provides valuable information on explosions for everyone involved in the operation, design, maintenance, and management of chemical processes, helping enhance understanding of the nature of explosions and the practical methods required to prevent them from occurring. The text includes: • Fundamental basis for explosions, • Explosive and flammable behavior and characteristics of materials, • Different types of explosions, • Fire and explosion hazard recognition, • Practical methods for preventing explosions or minimizing the potential consequences, and • Additional references.

This book provides a practical understanding of explosion fundamentals, including the different types of explosions, the explosive and flammable behavior of materials, and the hazards related to fires and explosions. It also discusses practical methods to prevent and minimize the probability and consequence of an explosion during routine use of flammable, combustible and/or reactive materials.

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The explosion occurred in the Gas House, where the pressurized containers are filled with propellant. On the day of the explosion, the containers were being filled with ethylene oxide for use as a sterilant. Ethylene oxide is a highly reactive, toxic chemical. As a result, the Gas House operator is required to wear a respirator with breathing air supplied by an air hose.

On the afternoon of June 24, 1997, the breathing air to the operator was interrupted, forcing him to quickly shut down the process and evacuate the building. After breathing air was restored, the operator returned to the Gas House to restart production. He noticed an alarm indicating a high level of hydrocarbon vapor. The concentration exceeded 40 percent of the lower explosive limit. As the operator left the Gas House, a large explosion occurred.

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## Status of Sache

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You can view the agenda for the 2003 SACHE Workshop, and download many of the presentations from the workshop web site (<http://www.mpri.lsu.edu/workshop>). Thanks to Ralph Pike and LSU for making this information readily available to all SACHE members.

The SACHE Committee will be identifying opportunities for future workshops and will provide this information as soon as possible.

## Essential Practices for Managing Chemical Reactivity Hazards

CCPS has teamed with US OSHA, US EPA, the American Chemistry Council, the Synthetic Chemical Manufacturers Association, and Knovel Corporation to make this important new CCPS concept book available for free on the Internet. "Essential Practices" identifies a simple process to determine if an operation may be at risk of a chemical reactivity incident, and then guides you to resources to manage that risk. With reactive chemistry hazards receiving a great deal of attention in the press, and with government agencies in recent years, chemical engineering students should be familiar with these hazards, and how to manage them. Please help to make students aware of this valuable, free resource, available at <http://www.aiche.org/ccps/>.

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## Accra Pac Group

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The EPA Chemical Accident Investigation Team believes the explosion was caused by ethylene oxide vapor that accumulated in the Gas House. The vapor exceeded the lower explosive limit and contacted an ignition source that initiated the explosion. The EPA identified the following root causes: inadequate shutdown procedure, location of the ethylene oxide reclamation tank inside the Gas House, lack of sufficient explosion barriers or separation between the Gas House and the Production Building, insufficient explosion venting, inadequate door design, and use of electrical equipment that did not meet National Electrical Code Requirements.

A copy of the full report is available at [http://yosemite.epa.gov/oswer/ceppoweb.nsf/vwResourcesByFilename/accrapac.pdf/\\$File/accrapac.pdf](http://yosemite.epa.gov/oswer/ceppoweb.nsf/vwResourcesByFilename/accrapac.pdf/$File/accrapac.pdf)

## SACHE Committee

The SACHE Committee is always looking for help in identifying and developing new products that would enhance safety education. Personally, I would like to see more products that address safety issues in some of the "non-traditional" areas in which many chemical engineers are working – biotechnology, electronics, chemicals, pharmaceuticals, and food processing. Currently SACHE does not have a many products in these areas, mainly because these technologies are not in the areas of expertise of the current committee members. If you have ideas for relevant products in these areas or are willing to help develop these products (or know somebody who is willing to help), please let us know. The SACHE Committee is holding most of its meetings by teleconference these days to allow people to participate more easily in this time of increasing pressure on travel budgets and time. We meet by teleconference every 6 or 8 weeks, typically for about 4 hours, to review products, identify potential new products, and identify potential product authors. We welcome additional participation from both the academic and industrial communities.

**SACHE BREAKFAST  
2003 ANNUAL MEETING**  
Tuesday, November 18, 2003  
7:00 a.m. to 8:30 a.m.  
Hilton Towers, Green Room  
(Check on site for locatation changes.)

You are invited to join us at our breakfast to learn what SACHE has been doing and what is on tap for 2004.

At the breakfast you will:

- Learn about new products for 2004,
- Learn about our future workshop plans,
- Have an opportunity to tell us what new products you would like to see, how you are using our materials, and what formats you would like us to use in the future, and
- Have an opportunity to network with other SACHE users.