SACHE News

CCPS CENTER FOR CHEMICAL PROCESS SAFETY
An AIChE Industry Technology Alliance

Safety and Chemical Engineering Education - Fall 2005

Status of SACHE

Dennis Hendershot and Bob Rosen
Co-Chairs, CCPS Undergraduate Education Committee

First of all, congratulations to the all of the SACHE and AIChE Safety and Health Division award winners, who are listed on Page 3 of this newsletter.

We have produced a new type of product on reactive chemistry hazards, described elsewhere in this newsletter. The product is intended to be an on-line, self directed tutorial for use by students, and provides an introduction to the subject, with many internet links to additional resources. The intent is that students could be assigned to review the module outside of class on their own schedules and at their own pace, and that this could be followed by classroom discussion. This product was produced by Bob Johnson of Unwin Corporation – Bob is the author of the CCPS book "Essential Practices for Managing Chemical Reactivity Hazards" and also teaches the AIChE short course on reactive chemistry hazards. We would also like to thank Dr. Dorothy Skaf of Villanova University and her students, who used an initial version of the product as a test and provided a lot of very useful feedback which was incorporated into the final product. We particularly encourage feedback to the SACHE Committee on this product – we would like to know if you would like to see more of this type of resource in the future.

The 2005 SACHE Workshop, sponsored by Rohm and Haas Company, Arkema, Inc., and Chilworth Technologies, Inc. was held at Rohm and Haas facilities in Bristol and Croydon, Pennsylvania, and at Chilworth's Plainsboro, New Jersey laboratories. We had about 40 participants in all, about 25 faculty attendees along with workshop instructors, SACHE Committee members, and other Rohm and Haas, Arkema, and Chilworth technical personnel. The program focused on batch polymer processing, reactive chemistry hazards, dust explosion hazards, and logic model based tools for incident investigation. Feedback from participants was extremely positive, and we will look into repeating a similar program in the future. Workshop materials are available for download from the 2005 Workshop web site – www.sacheneu.com. The SACHE Committee thanks Ron Willey of Northeastern University for organizing the workshop, and all of the sponsors for their support, both financial and in making people available to participate in the workshop.

The SACHE Committee will meet at the AIChE National Meeting in Cincinnati at noon on Sunday October 30. Please check for information on the list of group meetings at the National Meeting. You are welcome to stop by and provide input for future activities.

AIChE Safety and Health Division Newsletter

The Safety and Health Division issues electronically a quarterly newsletter to enhance communication between its members and affiliated organizations. The newsletters are posted on the Division web site at http://www.chem.mtu.edu/org/aiches&h/newsletter.html for downloading or reading.

TABLE OF CONTENTS

Volume 15, No. 2 – October 2005

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.

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Graduate Student Experiences at the 2005 SACHE Workshop

Editor's Note: Three graduate students attended the 2005 SACHE Workshop in Bristol, Pennsylvania, on September 18-21. These are the summaries of their experiences "in their own words."

Cristina Piluso
Wayne State University

The 2005 SACHE workshop for chemical engineering faculty and graduate students was an excellent learning experience for all in attendance. I came in not knowing what to expect and left feeling very fortunate for having the opportunity to attend. The workshop provided me with many tools and references, which will prove beneficial to me throughout my studies and beyond.

The highlights of the four days were the a) Rohm and Haas Bristol Polymers plant tour and b) tabletop exercises. The plant tour provided us with a first hand view of the safety measures and precautions which plants utilize, while the tabletop exercises, in particular the incident investigation exercise, was valuable because it allowed us to develop and apply fault trees to a "real" incident and, furthermore, allowed us to suggest recommendations. Having the knowledge of how to perform an incident investigation correctly is especially useful for professors and graduate students. This was truly a unique and valued experience.

Additionally, I found it particularly useful to talk with the other graduate students and workshop participants, as their suggestions and ideas helped me further understand and appreciate the importance of chemical process safety. Although most workshop participants came into the workshop from different academic backgrounds within chemical engineering, we all left with a significant understanding and appreciation of the need for an increase in the awareness of process safety in chemical engineering education, at the undergraduate and graduate levels.

I highly recommend attendance in future SACHE workshops to professors and graduate students; the lessons learned during the short time span are invaluable.

Anjana Meel
University of Pennsylvania

The SAChE 2005 Workshop sponsored by Rohm & Haas, Arkema, Inc., and Chilworth Technologies was indeed a successful workshop. It provided a platform to learn the basic, as well as the advanced, concepts of safety of chemical plants for graduate students and faculty. The sessions focused on several topics of safety of chemical plants that should be included in undergraduate and graduate education at universities. The latest technologies to handle the safety concerns were also discussed.

The workshop was really helpful for me, as my thesis focuses on safety and risk analysis of chemical plants. In particular, sessions on dust explosions and incident investigation were really stimulating. The tour of the polymer plant at Rohm & Haas was good experience to see the implementation of safety systems in a real plant. It also provided a good knowledge of plant components and control rooms. The exercise to investigate an incident was really exciting and gave an opportunity to apply what we learned.

The dinner arrangements were especially wonderful, as it provided informal setting to talk to experts from industry and academia, and obviously, the food was delicious. Overall, it was a great opportunity to interact with safety experts from industry and academia.

Felix S. Rantow
Drexel University

Participating in the 2005 SACHE Faculty workshop proved to be a one-of-a-kind experience. Meant to be for faculty, graduate students were also included in the workshop. The opportunity to interact with safety experts

Continued on Page 4

Graduate Student Experiences

Continued from Page 3

and practicing safety engineers provided invaluable experience, no exception to graduate students.

My personal understanding of safety changed immediately with the opening presentations and discussions on dust explosions. The smaller things often cause the biggest problems. Presentations by Angela Blair (CSB), Rich Matusewicz (Arkema Inc.) and Vahid Ebadat (Chilworth Technologies) gave a thorough introduction to the hazards of dust explosions. The need for increased awareness, identification, and prevention of dust explosion hazards is critical. The practice of safety awareness and prevention is directly applicable to academic and research-scale industrial laboratories. These are the typical places where graduate students are working. The following visit to Chilworth Technologies provided a unique introduction to scientific test methods and state-of-art instrumentation toward quantifying hazards associated with dust explosion. At the end of the first day, Arkema's Rob DiValerio's personal take on safety drove the message home: safety should not be taken lightly.

Following the discussions on hazards of dust explosion, the workshop continued the next day with technical talks by practicing consultants and engineers from Unwin (Robert Johnson) and Rohm and Haas (Joe Jacobs, Gary Van Sciver and Alan Keiter), mostly on identification and prevention of safety hazards in chemical processes. Technical text on the subject matter is abundant, and the message to be had was for us to take the time to assess safety, as engineers are responsible for the safety of the people around us. This could simply mean paying closer attention to the nature of the reactive chemicals involved, design basis of the emergency relief system, basic process control systems, and basic engineering calculations that are associated with the design of the relief systems. Every effort put on the drawing board directly translates to saving human lives.

On the last day, Dennis Hendershot of Rohm and Haas closed the workshop with a series of talks, all focused on the importance of incident investigation. While one needs to learn from past mistakes, in the case of process safety, one simply could not afford to make any mistakes. In the unfortunate case that an incident does happen, one needs to use the opportunity to learn as much as possible from it. Dennis conveyed the message loud and clear: only through effective incident investigation can one make progress toward improving future safety. The use of logic trees was used as an example of a typical approach towards identifying root causes, and the opportunity to use the approach in a group-work setting was a particularly insightful and entertaining exercise.

The whole thrust of the workshop should not escape us, awareness of safety and exposure to the culture of safety begin in classrooms and small academic laboratories. I am certain that the workshop did more than exposed the culture of safety to the participating graduate students; simply put, it changed our lives. Should the opportunity present itself, I am confident that the short experience will have a positive effect on our future career paths.

I would particularly like to thank Professor Ron Willey, Deb Shapiro, AIChE/CCPS/SACHE, and the host companies (Rohm and Haas, Arkema Inc. and Chilworth Techonologies) for including and assisting the graduate students in the workshop. Hopefully the graduate student participation will continues to be an integral part of future SACHE Workshops.

CCPS Process Safety Resources

The CCPS offers several process safety resources at http://www.aiche.org/ccps/resources.htm. These documents may be freely printed, downloaded, and shared. This is an excellent resource for bringing process safety topics into the classroom.

Each month, the *Process Safety Beacon* brings a lesson about an important process safety topic directly plant operation personnel.

Safety Alerts offer short process safety communications to aid industry in implementing elements of a good process safety program.

Under *Managing Chemical Reactivity Hazards,* CCPS offers four important resources to assist companies that handle and manufacture chemicals to avoid catastrophic chemical reactivity incidents:

SACHE and Safety and Health Division Awards

SACHE Safety Awards

Walt Howard Individual Safety Design Award, $200

Ben Koenigsknecht
Michigan State University

Jack Wehman Team Safety Design Award, $300

Jon Fleener, Ryan Michael Sistrunk, and Kenneth Wayne Proffitt
Lamar University

Safety and Health Division Awards

Ted Ventrone Awards for Inherent Safety, $500

Christopher Hill
Michigan Technological University

H. Marcy Hammer and Christopher Katinas
Rose Hulman Institute

Zeena Kas and Mihai Manitiu
Wayne State University

Justin Guinn, Robert T. Taylor, and Tim Plowman
Oklahoma State University

SACHE Products for 2005

The following 2005 SACHE educational resourses are availble to member universities through the SACHE website (http://www.sache.org):

Chemical Reactivity Hazards
Emergency Relief System Design for Single and Two-Phase Flow
Introduction to Biosafety
Runaway Reactions - Experimental Characterization and Vent Size
Simplified Relief System Design Package
Solutions to Student Problem Set Volume 1
Solutions to Student Problem Set Volume 2
University Access to SuperChems and ioXpress

SACHE representatives have their institution's userid and password.

Emergency Relief System Design for Single and Two-Phase Flow

Ron Darby
Texas A&M University

This design module covers the principles and procedures for sizing emergency relief systems for both single-phase (gas or liquid) and two-phase flow, including relief devices as well as inlet and discharge piping. The Homogeneous Direct Integration method for two-phase flow described herein is simpler, more general, and more rigorous than methods previously presented. The material is in a form which could be incorporated into courses on applied fluid mechanics, process safety, or process design, or it could be presented separately as a "stand alone" topic. It is assumed that the student has a familiarity and working knowledge of the macroscopic conservation laws for mass, energy, and momentum, and Newtonian fluid flow through pipes and fittings, including incompressible as well as compressible flow up to and including choked flow. Several worked examples are included which serve to illustrate applications of the procedures and equations, or which can be used for student exercises. A PowerPoint presentation is included, as are the spreadsheet calculations for the example problem solutions.

Chemical Reactivity Hazards

Robert Johnson
Unwin Company

This web-based instructional module contains about 100 web pages with extensive links, graphics, videos, and supplemental slides. It can be used either for classroom presentation or as a self-paced tutorial. The module is designed to supplement a junior or senior chemical engineering course by showing how uncontrolled chemical reactions in industry can lead to serious harm, and by introducing key concepts for avoiding unintended reactions and controlling intended reactions. The five main sections in the module cover (1) three major incidents that show the potential consequences of uncontrolled reactions; (2) how chemical reactions get out of control, including consideration of reaction path, heat generation and removal, and people/property/environmental response; (3) data and lab testing resources used to identify reactivity hazards; (4) four approaches to making a facility inherently safer with respect to chemical reactivity hazards; and (5) strategies for designing facilities both to prevent and to mitigate uncontrolled chemical reactions. The module concludes with a ten-question informative quiz. An extensive glossary and bibliography are directly accessible from any page.

Introduction to Biosafety

Art Schwartz
Bayer Corporation (retired)

Biohazards are agents that are biological in nature and have the capability to cause harm to biological organisms. This module is intended to provide a brief overview of the area of BioSafety. A Powerpoint presentation provides an introduction to types of Biohazards and discusses sources of biohazards, classifications of biohazards by risk group, and methods of reducing risk from biohazards. Also discussed are Waste Handling and Universal Precautions. The module is oriented towards dealing with biohazards in a laboratory or clinical setting. Included with the module are several examples of Biosafety Manuals that are typically used in corporate (BiosafetyManual.zip) or public health organizations such as the US Department of Health and Human Services (DHHS) and the World Health Organization (WHO).

Continued on Page 7

SACHE Resources

Continued from Page 6

Simplified Relief System Design Package

Ed Kitchen
Digital Solutions Technology, Inc.

The Mach II system is unique to any other relief system design software because it is custom designed specifically for speed, user-friendliness, flexibility, compatibility, API/ASME single-phase sizing, and DIERS two-phase methodology. In short the Mach II is easy to learn simple to use, yet comprehensive. The Mach II program will calculate the required capacity of each relief scenario not already input by the user, and will then calculate the required and standard orifice size and standard relief capacity. The program will then select the worst-case scenario, largest required orifice, as the basis for the design of the relief system to include the associated piping. The program also has a built-in piping program where the user can choose the number and type of fitting for both inlet and outlet piping. Mach II then calculates the piping resistance and pressure drop for this piping arrangement. Mach II is intuitive to use and the results are produced instantaneously by just clicking on the Generate Report tab after all input data has been entered. Mach II was designed based on the requirements as set forth in OSHA 29 CFR 1910.119a whereby relief system design and design-based calculations must be compiled and maintained for all processes involving highly hazardous chemicals.

University Access to SuperChems and ioXpress

Georges A. Melhem
ioMosaic Corporation

SuperChems is an advanced tool for pressure relief design, consequence analysis, and thermal hazards assessment. Developed by ioMosaic, SuperChems helps companies meet process safety design objectives and management needs. Its rigorous modeling capabilities enable companies to make technically sound decisions about key process design issues. SuperChems contains an extensive database of more than 1200 components with equation-of-state based computer code and incorporates many features that add tremendous value to the quality of a detailed hazards analysis. It has been extensively validated against experimental data to ensure its accuracy.

Continued on Page 8

Runaway Reactions – Experimental Characterization and Vent Sizing

Ron Darby
Texas A&M University

This module is an updated and revised version of the module entitled "A Unit Operations Laboratory Experiment for Runaway Reactions", published by SACHE in 2001. The title has been changed to reflect the more general utility of the module for education, training and instruction of personnel in industrial, governmental or other laboratories who are concerned with the characterization and sizing of relief vents for runaway reactions, in addition to universities who would like to include this subject matter in lecture and/or laboratory courses concerned with process safety.

The Advanced Reactive Screening Tool (ARSST) is an easy to use and cost effective calorimeter that can be used to quickly and safely identify potential chemical reactivity hazards. It can also yield critical experimental data on the kinetic characteristics of runaway reactions that can be scaled up to full scale process conditions and can be used directly to estimate the size of a relief device that would be required to protect the reactor against the over-pressure that would result from a runaway reaction.

This instruction module describes the ARSST and its operation, and illustrates how this instrument can easily be used to experimentally determine the transient characteristics of runaway reactions, and how the resulting data can be analyzed and utilized to size the relief vent for such systems. It can also be easily incorporated into a Chemical Engineering Unit Operations Laboratory as an effective educational laboratory experiment utilizing a practical and physically realistic example reactive system.

SACHE Resources

Continued from Page 7

Solutions to Student Problem Set Volume 1

J. R. Welker and C. Springer
University of Arkansas

Volume 1 was originally published by CCPS in 1990. Copies were given to universities and sold to industry. This was a very popular and valued product that is currently out of print. J. Wagner (Oklahoma State University) recently put this product in electronic format for distribution. The Instructor's Manual is available only to member universities, but the Student Problems are publicly available at http://www.sache.org/links.asp.

The 90 problems involve issues of safety, health, and loss prevention and provide students and new engineers with important insights to industrial processes. This material can also be used as a reference for industrial courses for new engineering employees. These safety problems and solutions further demonstrate that safety and health issues are handled with basic engineering principles and logic. Finally, through the use of this material, we hope to instill in students and engineers an increased recognition of the importance of chemical process safety and the recognition that they have the professional and ethical responsibility to provide safe chemical plants, processes and products.

The problems were designed for use in existing engineering courses, such as: stoichiometry, material balance, mass transfer, heat transfer, thermodynamics, process control, and design courses. The authors believe that it is important that students work on these problems while attending their undergraduate courses and throughout their education. This process should develop a safety culture within engineers that will help them throughout their careers.

Solutions to Student Problem Set Volume 2

R. Willey, Northeastern University
D. Crowl, Michigan Technological University
R. Welker, University of Arkansas
R. Darby, Texas A&M University

Volume 2 was originally published by CCPS in 2002 and distributed to SACHE University Members. This was a very popular and valued product that is now out of print. R. Willey recently put this volume in electronic form for distribution. The problems are available at http://www.sache.org/links.asp.

Like the Volume 1 problems, the 218 problems teach safety, health, and loss prevention. This solution set represents problems and solutions produced by SACHE in the period 1990 to 2000.

The problems were designed for use in existing engineering courses, such as stoichiometry, thermodynamics, fluid mechanics, kinetics, heat transfer, process dynamics and control, computer solutions, and mass transfer. The authors believe that including these problems in a required undergraduate course helps engineering students develop a safety culture and mind set that will benefit them throughout their careers.

Job Safety Analysis for Chem-E-Car Competition

Daniel Crowl, Bob Rosen, and Joseph Louvar have developed a sample job safey analysis form to help identify potential hazards during the construction and operation of Chem-E-Cars. The form includes hazard identification, hazard controls, and required personal protective equipment. Available safety equipment and systems are also surveyed. The form can be downloaded from http://www.sache.org/links/louvar6sept2005/JSA_ChemCarCompetition.doc.