The University of Iowa

EDITOR: JENNA STOLTZFUS

AIChE Fall 2014-Spring 2015

Advisor's Corner

By: Prof. David Murhammer, Professor and AIChE Student Chapter Advisor

Greetings to Hawkeye Chemical Engineers!! This combined Fall 2014/Spring 2015 issue of our AIChE Student Chapter Newsletter is dominated by student work from Professor Jessop's Process Calculations course and my Chemical Process Safety course. This includes 4 students papers about applications of Chemical Engineering from the Process Calculations course and 6 student papers from the Chemical Process Safety course, 3 of which are opinion papers about the best chemical regulation approach for the United States and 3 of which are opinion papers about the best approach to chemical plant security in the United States. This newsletter also contains articles about the Fall 2014 AIChE Annual Student Conference, a co-op experience at Cargill, and chemical engineer student participation in intramural sports. Fourteen of our students and I attended the AIChE Annual Student Conference held in Atlanta. As indicated in the article, our student chapter actively participated in this conference and received numerous awards, including winning the National ChemE Jeopardy Championship for the 2nd consecutive year. Our AIChE Student Chapter sent 19 students and 2 faculty (Professor Jessop and me) to the 2015 Mid-America Regional AIChE Conference. We had five students presenting their research at this meeting and had two competing ChemE Jeopardy teams. One of these teams (Matt Johnson, Zach Behrendt, Jacob Crome and Alex Bartlett) won the regional competition to qualify for the national competition being held on November 7th in Salt Lake City. This team will be attempting to become the third consecutive team from the University of Iowa to win the national championship.

University of Iowa American Institute of Chemical Engineers

INSIDE THIS ISSUE:

AIChE THE UNIVERSITY OF IOWA

Fall 2014 AIChE Annual Student Conference

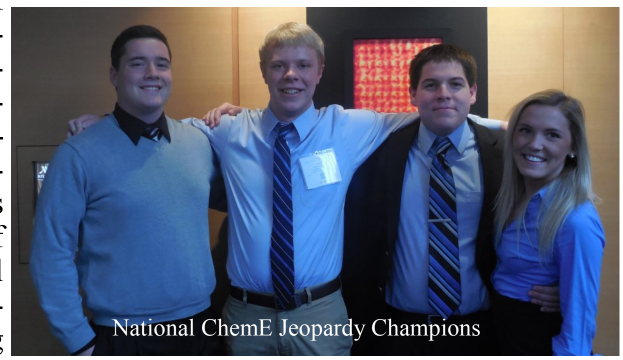
By: Anthony Miller

On the morning of November 14th, 14 students from the University of Iowa headed to Atlanta, Georgia for the AIChE Annual Student Conference. The conference brought over 130 schools together from across the country for a four day professional and social event. The conference kicked off with a networking brunch keynoted by John Brock, Chairman and Chief Executive Officer of Coca-Cola Enterprises in Atlanta, Georgia. Setting the day in motion, everyone was ready for the main focus of the day, the professional and student workshops.

These workshops provided opportunities for students to learn about career opportunities and to obtain suggestions about improving their AIChE student chapters. University of Iowa students Kayla Racinowski and Valerie Renkor gave a presentation about getting the most out of your student chapter. This presentation was co-presented by members from student chapters at the University of South Florida and the University of Virginia. During the workshop, schools shared how their chapters operated, ways to get more participation and enrollment within student chapters, and social activities held for student members. Participants were encouraged to ask questions and share ideas about improving their AIChE student chapters. A captivating presentation by Valerie and Kayla proved why Iowa's student chapter truly is the best.

Conference attendees also participated in career workshops. More than twenty different workshops were offered that involved chemical engineering disciplines and sectors of industry. Each session was given by an industry leader or a standout in a particular field of study. These workshops gave students opportunities for improving their career paths and/or improving their student chapters.

Following an already full day of career and student workshops came the climax of the national conference (from the University of Iowa's perspective): the Chem-E Jeopardy Competition. Competitors were composed of winners of regional competitions and included the following schools: City College of New York, University of Kentucky–Lexington, Oregon State University, Louisiana State University, Texas A&M University, Trine University, University of California-Berkeley, University of Utah, Worcester Polytechnic Institute and University of Iowa. The members of the University of Iowa were Danny Yocius, Catherine Suchanek, Jake Crome and Zach Behrendt. After preliminary rounds there stood only three schools: Louisiana State University, University of California-Berkeley, and the University of Iowa. After completing Single Jeopardy and Double Jeopardy, the University of Iowa was the only team with a positive score and therefore the only team allowed to compete in Final Jeopardy. The University of Iowa was victorious to bring home the title of national champions for a second consecutive year!



National ChemE Jeopardy Champions

In order to celebrate their victory, the Jeopardy competitors and their fellow classmates participated in the student bash. Music filled the ballroom for all to enjoy while students sampled the hors d'oeuvres. Students were filled with anticipation of the announcement of the school spirit award. The winner was determined by the best snapshot taken of the night. Even though there was no official winner, the University of Iowa's snapshot would have taken first place.

The following day brought about the Chem-E Car Competition, student award ceremony, and the recruitment fair. 33 teams representing multiple different regions competed for the title of national Chem-E Car champion. After literally hours of runs, the University of Utah's Car pulled out the first place win. Receiving second was Manhattan college, followed by the University of Toledo. Along with their national rankings, the teams also received financial awards of $2000, $1000 and $500, respec-

Fall 2014 National AIChE Conference (continued)

tively.

While the Chem-E Car Competition was underway, the Career Development Fair was simultaneously taking place. Fair participants included companies such as Exxon Mobil, Aspen Technology, and DuPont --just to name a few. In addition to the multiple companies looking for potential employees, there were over 50 graduate schools looking for the best of the best of graduating chemical engineering students. A poster competition was also taking place where undergraduate students shared their research with other students and faculty. The posters were judged by faculty and industrial representatives. The University of Iowa student presenters were Catherine Suchanek, Katie De Hoedt, and Adam Johns.

The AIChE Student Award ceremony highlighted notable achievements of student members during the 2013-2014 academic year. Many University of Iowa students received awards, including the Donald F. & Mildred Topp Othmer National Scholarship Award to Daniel Yocius and the Donald F. Othmer Sophomore Academic Excellence Award to Nathan Schuchert. Furthermore, University of Iowa Students won the Safety and Health Division National Design Competition Award for Inherently Safer Design. Specifically, two teams from the University of Iowa won this award for the 2014 Design Competition: a team consisting of Tyler Latcham, Kyle Owen and Joseph Brodt and a second team consisting of Nevin Vijh, Robert Tempel and Megan Hall. Finally, for the 10th consecutive year the University of Iowa was the recipient of the Outstanding Student Chapter Award for 2013-2014, marking the school's 21st win out of the last 22 years.

To wrap up the eventful weekend, University of Iowa student explored Atlanta. This included walking around in hopes of finding a good restaurant, visiting the Atlanta Aquarium and watching a spectacular dolphin show. This time allowed for the students to bond with one another as well as be exposed to the community of Atlanta. In attending this event, students were given the opportunity to meet other students from other regions, further develop themselves as professionals and find ways of improving their student chapter.


University of Iowa National AIChE Conference attendees

Should Inherently Safer Design be Required?

By: Joe Warmuth

In Anacortes, Washington in 2010 a fire and explosion in an oil refinery killed seven workers when a pipe ruptured during routine maintenance. This is just one of the many accidents that have occurred that could have been avoided with the help of inherently safer design. Inherently safer design, proposed by Trevor Kletz, not only minimizes the risk of an accident, but can also minimize the risk of attacks on chemical facilities. Inherent safety design is unquestionably necessary, although some argue that it is a given and should not be required by law and that it will make it more difficult for companies to operate profitably. Steps have been taken towards improving safety in chemical plants, but these steps have not been substantial enough or quick enough. Inherently safer design should be required by law because, even though it seems to be an obvious choice to implement it, some companies may not fully understand its importance until it is too late.

As an illustration, more than 1.2 million workers in the United States in 2009 missed time from work due to injuries resulting from industrial accidents. Another 4,340 workers were killed as a result of industrial accidents in the U.S. in 2009. The number of accidents in 2009 was a nine percent decrease from 2008 (Dugas, 2015). With inherent safety design, these numbers could continue to decrease each year. The hierarchy of actions developed by Trevor Kletz should be used to help implement inherent safety design. The four paths developed by Kletz are: minimize the use of hazardous chemicals, substitute or replace hazardous chemicals with safer ones, moderate or shift to less hazardous chemicals or processes at lower temperatures and pressures, and simplify processes and design plants to eliminate unnecessary complexity (Hess & Johnson, 2014).

Additionally, in 1993 the World Trade Center was bombed by terrorists, one of which was Nidal Ayyad. Ayyad worked for a New Jersey chemical company and used his position to steal chemicals from the company to make the bombs. He also stole cyanide which he intended to release in the office-building ventilation system (Kaplan, 2006). Under the Chemical Facility Anti-Terrorism Standards (CFATS), chemical companies are required to make financial investments to improve the security and safety of their plants. This includes protecting their facilities from potential attacks and preventing theft of dangerous chemicals (Hess & Johnson, 2014). Unfortunately, CFATS has been operating under temporary authority because lawmakers are reluctant to pass free-standing legislation that would formally authorize CFATS and make it a more permanent solution (Hess, 2014). CFATS, which is run by the Department of Homeland Security (DHS), is an effective start to mandated inherent safety design, but more still needs to be done and CFATS needs to have more formal authority.

Furthermore, the advocates against government mandated inherent safety design believe that it is common sense and therefore do not see a need for it to be regulated and required. As stated by Christine Todd Whitman, the former Environmental Protection Agency (EPA) administrator, requiring facilities to use safer chemicals and processes "when they're available, effective, and affordable is common sense. Many companies have acted responsibly, but far too many others have not." (Hess & Johnson, 2014). For some, implementing inherent safety design would be considered cost-ineffective and therefore they would not implement it unless required by law. Some also argue that by requiring certain steps to be taken, such as reducing chemical storage inventories, that it does not allow these companies to have enough inventory to meet customer needs (Hess & Johnson, 2014). While this may be true, the safety and lives of the general population supersede the company's desire to make a profit. Additionally, since CFATS is only under temporary authority, chemical facility operators are hesitant to spend money to comply with the standards if the standards may not exist for more than a year (Hess, 2014). This is another reason that CFATS needs to be given more permanent authority.

President Barack Obama issued a directive in August 2013, which ordered a team of federal officials to recommend ways to improve the safety and security

Should Inherently Safer Design be Required? (continued)

of chemical plants (Hess, 2014). This team consists of officials from the Environmental Protection Agency (EPA) and the Occupational Safety & Health Administration (OSHA). Their main goal is to begin working on voluntary guidelines for chemical facility operators to follow on how to integrate inherently safer design (Hess, 2014). As explained by the Coalition to Prevent Chemical Disasters, there are already federal programs that require facilities to make operations safer and therefore the task force created by President Obama may just be duplicating efforts (Hess, 2014). Instead of producing multiple programs with the same goal, efforts should be consolidated in one group, possibly CFATS, to provide one consistent set of guidelines for with chemical facilities to comply.

Finally, between the millions of accidents and the potential terror attacks, more stringent laws need to be enacted in order to decrease accidents and to increase plant security. Utilizing Kletz's hierarchy of actions, enforcing CFATS, and creating voluntary guidelines are good starting points, but it is not enough. Chemical manufacturers must be held to a higher standard, even if that entails less profit, in order to ensure the safety of the employees and general public.

References

Dugas, C. (2015, April 16). *The 4 Main Causes of Accidents in a Chemical Plant*. Retrieved from Clay Dugas Web Site: http://www.claydugas.com/refinery-injuries/main-causes-accidents-chemical-plant/

Hess, G. (2014). Panel Calls for Safer Processes. *C&EN*, 5.

Hess, G. (2014). Plant Security Gains Ground. *C&EN*, 30-31.

Hess, G., & Johnson, J. (2014). Another Look at Plant Safety. *C&EN Washington*, 11-16.

Kaplan, E. (2006, December 11). *Targets for Terrorists: Chemical Facilities*. Retrieved from Council on Foreign Relations: http://www.cfr.org/united-states/targets-terrorists-chemical-facilities/p12207#p7.

Algae as a Biofuel: Benefits and Engineering Requirements

By: Jeff Hamilton

As world food demands continue to increase, the need to produce more food and the need for alternative energy sources, such as biofuel, are competing for the same tillable ground. Currently, most biofuels come from soy beans and corn, which have a production rate of approximately 48 gallons and 18 gallons per acre, respectively. In contrast, algae can produce biofuel at up to 2500 gallons per acre and can be grown in non-arable areas not suitable to conventional agriculture. Increasing global demands for food and energy necessitate the allocation of scientific, agricultural, and engineering resources to invent efficient processes to replace corn and soybeans with algae in the production of biofuels.

Presently, algae is being pursued as a source of oil similar to soy beans, and the most common processes of extracting the oils follow the methods used for soybeans. Soybean oils are extracted by the use of hexane solvents. Unfortunately, hexanes easily evaporate and are toxic, creating hazardous fumes that could leak into either the workplace or the environment. Recent research has involved the use of ionic liquids as a means of extracting the oils. Ionic liquids are salt fluids that have very low rates of evaporation and many are both non-toxic and biodegradable, eliminating the risks involved with hexane solvents. Some ionic liquids have the ability to dissolve cellulose, which is the primary component in the algae cell wall. The process design dissolves the cell wall and re-

Algae as a Biofuel: Benefits and Engineering Requirements (continued)

leases the oils. Upon separation, the oils are refined into various biofuels, while the recovered cellulose can be converted into animal feed or utilized in the paper products industry, reducing tree consumption (Grasvik). Chemical engineering assets need to be allocated for both the refinement of the processes incorporating ionic liquids in order to reduce the use of petroleum solvents as well as replacing soybeans with algae as the primary source of biodiesel.

A solvent-free method of extracting oil from algae is being developed by the U.S. Department of Energy's Pacific Northwest National Laboratory in Richland, Washington, which has revisited an older technology, researched during the 1970's oil crisis, called hydrothermal liquefaction. This process was originally researched to gasify biomasses such as wood and later abandoned when energy prices returned to normal levels (Nguyen). The process involves heating an algae and water mixture and putting it under high pressure to simulate the natural processes which produce crude oil. According to Nguyen, the Richland researchers have discovered a way to not only replicate, but speed up this "cooking" process to the point where a small mixture of algae and water can be turned into a kind of crude oil in less than an hour. Besides being readily able to be refined into burnable gases like jet fuel, gasoline or diesel, the proprietary technology also generates, as a byproduct, chemical elements and minerals that can be used to produce electricity, natural gas and even fertilizer to perhaps grow even more algae. An analysis has shown that implementing this technique on a wider scale may allow companies to sell biofuel commercially for as low as two dollars a gallon.

This method, without the use of chemical solvents, may be the most promising process for an environmentally friendly production, and if the production cost estimates are accurate, the most economically feasible design to date.

An obstacle to the commercial use of algae as a biofuel source is the ability to produce the necessary quantities of raw material required to make a sizeable impact on the diesel requirements of the US. The resources required for substantial algae production on a scale necessary to provide a considerable percent of the US needs for fuel has been studied by multiple organizations. One study has used algae grown in pond farms of between 250 and 1000 acres providing algae to production facilities and concluded that due to climate conditions in the US, only about 2% of the nation's diesel fuel needs could be replaced by algae-based bio-diesel, and that fuel would need to be sold at over $300 per barrel to be profitable (Lundquist). In a study conducted by the US Department of Energy, it was estimated that the amount of land required to replace the nation's diesel requirements with algae would be about 15,000 square miles (about the size of Maryland), whereas it would require half of the total US land mass to accomplish the same results with soy beans (Nguyen). With algae being a single cell organism, neither the tillable acreage required for conventional crops nor large surface area ponds are required for growth. An alternative to growing algae in ponds is to use clear plastic bags with sugar feeds. While this method is more costly, contaminants are reduced and production per unit land area is greatly increased (Rhodes). In addition, research is occurring in the genetic modification of current algae species to maximize oil production levels per cell. The ability to grow algae as a cash crop on non-tillable acreage will incentivize the agricultural industry to develop production methods to supply the quantity required at a minimal cost.

While much research is being done to make algae a viable source for biofuels, the economic realities of the current processes are a major hurdle to overcome. There have been considerable advances in the use of algae for fuel production and some small-scale facilities have been produced, but it will take considerable engineering in process design and production methods to make the use of algae economically feasible. Some processes need more efficient extraction methods by the use of better, more environmentally friendly solvents. Increased energy conservation and reduced material requirements are necessary for some processes to be efficient enough for profitable commercial. The ability to grow and harvest large quantities of algae in a relatively small area is a requirement of all designs. These are all problems that need

Algae as a Biofuel: Benefits and Engineering Requirements (continued)

strong chemical engineering to overcome and with the world's growing energy demands, fading fossil fuel deposits, and a growing population with greater food requirements, chemical engineers need to concentrate on inventing processes to solve the production problems of algae based biofuel.

References

Grasvik, John, Dilip G Raut and Jyri-Pekka Mikkola. "Challenges and Perspectives of Ionic Liquids vs. Traditional Solvents for Cellulose Processing." *nova publishers*. n.p. 2012. Web. 19 October 2014.

Muffoletto, M. "Algae biofuel can help meet world energy demand, researchers say". *Phys.* n.p., 26 May 2014. Web. 17 September 2014.

Nguyen, Tuan C. "Scientists Turn Algae Into Crude Oil In Less Than An Hour." *Smithsonianmag*. n.p. 31 December 2013. Web. 17 September 2014.

Rhodes, Christopher J. "Oil from Algae; Salvation from Peak Oil?" *Science Progress* 92.1 (2009): 39-90. Document.

T.J. Lundquist, I.C. Woertz, N.W.T. Quinn, J.R Benemann. *A Realistic Technology and Engineering Assessment*. University of California Berkeley: Energy Biosciences Institute, 2010.

Cargill Project Engineer Co-op Experience

By: Shandy Porter

I am currently working as a project engineer at a Cargill soy bean oil refinery in Sioux City, Iowa. My job description is to help a full time process optimization engineer with his various projects along with a few projects of my own. For the first month my time was focused on training and becoming familiar with the operations within the different components of the refinery so I'd have a strong foundation. After that, I took on my first project of getting a new AC unit for the refinery offices which taught me the process of how projects are completed. Since then, I've taken on multiple other projects along with covering for my supervisor when he leaves for training or vacation.

Two months into my co-op experience, my supervisor had to leave for a week long training session and I got the opportunity to see just how hectic it can be to be a project engineer. The Friday before he left, I was brought up to speed on all of his current projects. Each day there was a large task to be completed in order to keep his projects up and running. On Tuesday, I encountered the biggest challenge of my co-op experience so far. It was my responsibility to help complete a line break of the load out systems in order for a contractor to safely demolish an old additive system.

The day before, I had done everything I could do to plan out and prepare the lock out procedure. However, once the project began I encountered problem after problem. One challenge I was faced with was a worker helping lock out the equipment stepped on and broke an air line. This caused the loss of all control to a majority of the valves in the tank farm. With the help of another worker, we got the air line shut off and safely repaired as fast as possible. Another problem arose when the schedule was changed and one of the load out lines was needed much earlier than expected. Knowing this, I went to the contractor and had them prioritize their work to include making the needed line available first. The contractors were able to quickly finish the demolition of the processes and had both lines available for unlock on time.

I learned a lot during this day of how to manage a project even when everything doesn't go as planned. The load out truck block was set for 8 A.M. to noon,

Cargill Project Engineer Co-op Experience (continued)

but due to the challenges encountered, the contractors couldn't begin work until 1 P.M. No trucks were scheduled until late that night so work could still continue. The unexpected schedule change of a truck being moved up posed a problem, but I was able to get things prioritized and communicated and the truck was only delayed a short time due to my project. Throughout the day, I encountered problem after problem but stayed calm and focused and did what had to be done to get the job accomplished. I couldn't have done it without the help of the loaders and refinery technicians that were willing to help me along with all the other supervisors who encouraged me throughout the day.

I have learned an immense amount from participating in this co-op so far. I have been shown just how a company works and been allowed to help improve the plant as it stands. I never imagined I'd be given the opportunity to take on the responsibilities of my boss at such an early time with no direct supervision. However, I'm constantly encouraged by the other employees around me and everyone is always so willing to help me if I'm not sure what to do. I am looking forward to the bigger projects and plant shut downs that are approaching and learning everything I can from them. Working for Cargill has been a great experience and I have learned an immense amount of valuable experience.

Inherently Safer Design: Is it Time for Government Intervention?

By: Nathan Schuchert

On the night of April 17, 2013, an ammonium nitrate explosion at a fertilizer plant shook the city of West, Texas, resulting in the addition of 15 fatalities and more than 160 injuries to the already massive tally of casualties caused by accidents in the chemical process industry (Hess & Johnson, 2014). Each time an event such as this one occurs, it begs the question: could this disaster have been prevented? In the overwhelming majority of cases, the answer is yes. The more important question, then, is: why wasn't it prevented? This is the concept addressed by the chemical process safety strategy known as inherently safer design (ISD). While common safety practices seek to install measures that attempt to stop an accident as it is happening or mitigate its effects, the goal of ISD is to eliminate the hazard at its source to stop a potential incident from occurring in the first place and nullify the need for additional complicated safety features. The ever-growing number of preventable disasters occurring in the United States is indicative of insufficient and outdated chemical process safety regulation. The federal government must take action and implement a policy requiring companies in the chemical industry to adopt ISD practices in their facilities.

Before examining ways for the government to implement new regulatory measures, it is important to look at some of the common faults of chemical plants, and how they can be prevented with ISD. ISD is a process design approach based on the principles of minimization, substitution, moderation, and simplification. Knowledge of how to apply each one to a chemical process is essential in making it inherently safer. For minimization, the goal is to have the smallest necessary quantities of hazardous chemicals on hand at any given time (Kletz, 1998). Ways this can be accomplished include (i) reducing a large stock of hazardous material to only the amount necessary and (ii) immediately reacting hazardous intermediate chemicals to minimize its inventory. For example, a 1974 explosion at a plant in Flixborough, England that claimed 28 lives was found to be 17 times larger than it needed to be (Hess & Johnson, 2014). Had the plant's inventory been kept at a minimum, those lives could have been spared. The principles of moderation and substitution tie in closely, as they seek to limit or completely remove the use of hazardous chemicals and replace them with others that do not present the same

Inherently Safer Design: Is it Time for Government Intervention? (continued)

risks (Kletz, 1998). In addition, companies should look to use moderate operating conditions by running processes at lower pressures and temperatures. Though the replacement of some chemicals is not possible in every case, companies should take every opportunity to re-examine their alternatives in a process. For instance, a 2008 explosion at a Bayer pesticide plant in West Virginia nearly resulted in the release of 13,000 pounds of methyl isocyanate, the same chemical that killed thousands in 1984 when it leaked from a chemical plant in Bhopal, India (Hess & Johnson, 2014). This Bayer plant was later able to remove its use of this chemical, thus eliminating the risk associated with it. Lastly, process designs should be simplified by removing unnecessary complexities in order to reduce the likelihood of operator error and make such errors more forgiving (Kletz, 1998). Possible effects of an over-complicated operating system were illustrated in an explosion at a Pasadena, Texas plant in 1989. The polymer-producing system was susceptible to becoming plugged, which required a multi-step procedure of manually opening and closing valves in the correct order. When this was not performed correctly, the resulting explosion was responsible for killing 23, injuring 314, and costing over $715 million (Crowl & Louvar, 2011). Clearly, the consequences of not implementing ISD can be catastrophic. Yet, incidents continue to occur year after year.

The repeated negligence of companies in the chemical industry to improve their processes to reflect the principles of ISD calls for government intervention. Some chemical engineers believe that ISD analysis is simply common sense, and do not see the need for it to be mandated by the government. While this would be ideal, voluntary compliance of government recommendations is uncommon. And with more than 470 chemical facilities in the United States that each put at least 100,000 people in danger if they have a toxic release (Hess & Johnson, 2014), the federal government needs to ensure that the safety of its citizens is maintained. In order to do this without overextending its influence, the Occupational Health and Safety Administration should begin by introducing regulations that focus on prior offenders. Requiring a thorough investigation of companies with a history of safety infractions before they are allowed to operate would be optimal for minimizing the cost of implementation, while targeting the greatest safety problems directly. This method would also allow for companies that do actually invest in ISD to keep going about their business without government interference to save time and money on both sides. Overall, there would be an incentive for corporations to implement ISD in order to avoid confrontations with the federal government that are harmful to their business.

Given the repeated occurrences of harmful and fatal accidents in chemical plants in the United States, it is paramount that all chemical plants in the country greatly reduce the risk of such events through the implementation of ISD in their processes. Because many corporations will not do so voluntarily, especially those with histories of poor safety practices, it has become absolutely necessary that the federal government introduce new regulations to require that chemical processes include all possible elements of ISD. Though there will never be a point when all risk of accident is eliminated, it is time for the government to take action to protect the lives of its people. In the words of Rafael Moure-Eraso, former chairman of the Chemical Safety Board, it is time to stop “sifting through chemical plant rubble from catastrophic accidents year after year”, and to “call on regulators to require – and for industry to adopt – what is known as inherently safer technology” (Moure-Eraso, 2014).

Inherently Safer Design: Is it Time for Government Intervention? (continued)

References

Crowl, D. A. & Louvar, J. F. (2011). *Chemical Process Safety, Fundamentals With Applications* (3rd Edition ed.). Boston, MA: Prentice Hall.

Hess, G. & Johnson, J. (2014, Mar. 10). Another Look at Plant Safety. *C&EN Washington*.

Kletz, T. (1998). *Process Plants: A Handbook for Inherently Safer Design.* CRC Press.

Moure-Eraso, R. (2014, Jan. 28). The Next Accident Awaits.

Chemical Engineers and Their Impact on Health Sciences

By: Maliah Kome

Chemical engineers have made strides in virtually every field of science. One field in particular, biomedical engineering, will soon see new advancements in the preservation of health due to the work of chemical engineers. Dr. Eric Nuxoll and his team have been doing research on a new way to treat the formation of bacterial biofilms on implanted devices in the human body, as well as explore methods of drug delivery. These innovations will impact the scientific community, the health care industry, and patients around the world.

First, chemical engineers are working to treat and prevent many medical problems. During surgeries, surgeons must be diligent in maintaining a sterile environment. However, in rare cases, bacteria can come into contact with the patient, causing major problems. Patients who are receiving prosthetic implants are at risk of infection. When bacteria enters the body, it can thrive in massive colonies on implants. For example, a hip-transplant patient is at risk for infections of multiple types of bacteria, including *Streptococcus aereus, Escherichia coli,* and *Pseudomonas aeruginosa* (Donlan, 2001). Treatment for such serious infections is expensive, time-consuming, and risky, often requiring the removal of the device and a second transplant surgery to replace the implant. The use of strong antibiotics is a futile attempt at treatment. The biofilms, many of which are able to be seen by the naked eye, aren't affected by medication. In fact, they are able to resist many types of treatment. According to a study on biofilms conducted by researchers at the Centers for Disease Control and Prevention in Atlanta, Georgia, "The nature of biofilm structure and the physiological attributes of biofilm organisms confer an inherent resistance to antimicrobial agents, whether these antimicrobial agents are antibiotics, disinfectants, or germicides" (Donlan, 2002).

Though treatment options are limited, there is another option. Dr. Nuxoll, a professor of chemical engineering at the University of Iowa, is working on a solution. His career path isn't necessarily what people expect for a chemical engineer. After working with materials and packaging, Nuxoll became interested in the health science and biomedical aspect of chemical engineering when he realized that reactive barrier membranes are developed according to mathematical methods that are virtually identical to those used in methods for drug-release (Nuxoll, 2014). Today, he and his team are developing a method to treat the formation of biofilms involving the use of iron nanoparticles within a polymer coating the device. By using an alternating magnetic current, the nanoparticles' reversing poles will heat the device, killing off the bacteria in the biofilm and reducing the probability of needing a second risky surgery. Magnetic induction doesn't harm the patient, and allows for a noninvasive solution to the problem (Nuxoll, 2014). *Pseudomonas aeruginosa*, mentioned above, is the bacteria strain chosen for the experimental trials run in Nuxoll's lab. Graduate students test different temperatures and exposure periods to study the effect on biofilms. They also combine these trials with the use of strong antibiotics in order to kill off bacteria once they are weakened by the heat (Nuxoll, 2014).

Other trials involve the use of a flow cell developed by another graduate student and designed to imitate an implant within the body. They are able to study the risk of bacteria detaching from the biofilms and spreading to other parts of the body during treatment. Dr. Nuxoll also leads a research project dealing with the pulsatile release of solutes, mainly in pharmaceuticals. He and his team are making innovative discoveries and

Chemical Engineers and Their Impact on Health Sciences (continued)

contributing to the growing involvement of chemical engineers in medical research areas (Nuxoll, 2014).

In the future, these methods will have an impact on the scientific community and health care industry. Dr. Nuxoll is confident that he and his team will have a product and method available for use in hospitals within the next ten years. He hopes that other researchers will realize that the use of heat to kill off infections within the body is a viable option for treatment (Nuxoll, 2014). The health care industry will benefit greatly from this method as well. They would be able to offer a noninvasive procedure for a life-threatening infection, helping both health care providers and patients. Chemical engineers contribute to nearly every field of science as well as other fields including law, business, and marketing. According to an article in *Chemical Engineering World*, "Chemical Engineers are closer than ever to finding cures for deadly diseases, defending our nation from hostile countries, and improving the standard of living for citizens" (Yamani, 2010). Chemical engineers can be found working nearly anywhere.

In conclusion, chemical engineers impact the world in multiple fields, but biomedical engineering and health sciences specifically are greatly benefitting from their research. Research is being done at the University of Iowa to develop new treatments for serious infections and efficiently deliver drug dosages by Dr. Nuxoll. Though he is confident in his research, he is hopeful that other researchers won't give up on developing other treatments, explaining, "There are solutions out there, they just need to be worked out" (Nuxoll, 2014). His research is another stepping stone on the path to a brighter future.

References

Donlan, Rodney M. (2001). Biofilm Formation: A Clinically Relevant Microbiological Process. *Oxford Journals, Volume 33* (Issue 8), 1387-1392. http://cid.oxfordjournals. org/content/33/8/1387.long.

Donlan, Rodney M. & Costerton, William J. (2002). Biofilms: Survival Mechanisms of Clinically Relevant Microorganisms. *American Society for Microbiology Clinical Microbiology Reviews, Volume 15* (Issue 2), 167-193. http://cmr.asm.org/content/15/2/167.short.

Nuxoll, Eric. Personal interview. 16 Sep. 2014.

Yamani, Zaki. The Future Relies on Chemical Engineers. *Chemical Engineering World*. 6 Mar. 2010. http://chem-eng.blogspot.com/2010/03/future-relies-on-chemical-engineers.html.

Chemical Engineers Get Active

By: Nathan Schuchert

In a rather unexpected turn of events, a few brave chemical engineers came together and stepped into previously uncharted territory. That is, the members of the newly formed "Fully Developed Turbulent Flow" team took part in what is thought to be the first intramural competition entered by a group consisting solely of chemical engineers.

The six members of this band of merry men were Zach Behrendt, Austin Bourgeois, Ian Boysen, Ian Nessler, Grant Purdy, and Nathan Schuchert. Determined to make a stereotype-defying statement, they all laced up and stepped on the basketball court at a packed University of Iowa Fieldhouse. In the first game, the team did precisely that. Powered by an all-around Steph Curry-esque shooting display from the squad and led by a 25+ point outburst from Schuchert, Fully Developed Turbulent Flow won the first competition handily, 67 – 47.

Despite their promising start, the team's initial success was unequaled

Chemical Engineers Get Active (continued)

in the remaining games. While they may have won in heart, that did not translate very well to the scoreboard. So, after a disappointing final three competitions, our Chem-E basketball representatives were eliminated from playoff contention.

However, the chemical engineers at the University of Iowa were not about to go quietly into the intramural night. A second athletic event was calling – this time, our AIChE chapter president Anthony Miller organized a co-ed team to compete on the soccer fields. The stakes were high, as this intramural was played as a single-elimination tournament. After a hard-fought battle, the president and captain (Miller) led the team to victory in the first match with the game's only goal.

Similar to basketball, there was a very tough opponent waiting for them in their subsequent game. That being said, the opposition this time around came in a slightly different form. On the eve of the next match, the vast majority of the chemical engineers on the soccer team did not make it to bed until the wee hours of the morning, if at all. The culprit responsible for this predicament was the looming deadline of two extensive lab reports in addition to a topical paper the following day. Come game time, all but one of the team members were either still working on their assignments or passed out due to exhaustion. Unfortunately, the team had no choice but to forfeit.

Though the final results of each competition may have been less than desired, in the end, everyone had a great time playing. It was a fun bonding experience to get out and compete on the court or on the field with classmates that we normally only see when holed up in the Seamans Center for inordinate lengths of time. The positive reactions to each intramural event led our chapter president, Anthony Miller, to establish a new cabinet position - the Intramurals Coordinator. Beginning in Fall 2015, Elvis Flores will take on this new position and lead the chemical engineers of the University of Iowa to even greater athletic success.

The Future of Water

By: Abby Haas

Water is one of the most important resources to preserve in our time. Major health problems arise when people and animals are in contact with contaminated drinking water. This is detrimental to civilizations all around the world. Chemical engineers are imperative for the development of solutions due to their involvement in water treatment before and after the water is polluted. As these solutions progress for the treatment of water, more complicated methods for reusing limited resources are discovered. Water pollution is one of the greatest crises of the modern era. Chemical engineering is crucial to the solution of this crisis because they see the process of water treatment from beginning to end.

Chemical engineers influence the extent of water pollution around the world. This happens before pollutant enters the water by the revision of chemicals that come in contact with water sources. As the condition of water is an increasing concern around the world, it is effective to not only treat the system that is tainted, but to develop methods to improve the safety of chemical emissions (3). This way, the process of water purification is more practical due to lessened and safer pollutants. An example of this is the chemical emissions that occur from farming. If the runoff from these farms has less effect on the water sources it comes in contact with, then the vastness of water contamination is much more containable. However, even in the presence of environmental precautions, the unavoidable truth is that pollution will reach water sources throughout the world regardless. According to Chemical Engineers in Action, the creation of technology that helps clean chemicals, or the creation of safer chemicals is a reason that chemical engineers have the ability to make a significant impact on the environment (1). This is encouragement for anyone interested in a career of chemical engineering; problem solving begins before the problem starts. A key aspect to this kind of treatment is the versatility of a chemical engineer's abilities in regards to the science of water treatment. "Because chemical engineers are well versed in chemistry, physics, mathematics, and engineering, they are suited to meet the challenges of all types" (1). One of

The Future of Water (continued)

these challenges includes the transformation of chemical compounds on a molecular level. Before entering a water system, safely designed chemicals can reduce the impact of the emission on the environment. As water usage around the United States increases with higher demand, the condition of water sanitation is crucial to the health of society and the environment (4). With the limitations set in place by chemical engineers, the aftermath of environmental impact is much more manageable.

After a water system is polluted, it is crucial that the problem is dealt with in an efficient and practical manner. Chemical engineers work on the timely management of unusable water, because water sources are becoming more limited. The efficiency of water treatment is also related to the method used. Similarly, the processes for purification are becoming more innovative throughout the field of chemical engineering (2). As a larger variety of pollutants are found in streams and rivers across the country, chemical engineers are designing new methods to discover the foreign substances in water (4). It is important that the methods of water purification improve as the demand for clean water increases. One of the most frequently used methods is Carbon-based and zeolite-based adsorption. This includes the use of an activated, highly absorbent form of carbon that removes impurities from water sources (3). Furthermore, the field of chemical engineering continues to discover inventive techniques for water purification, making the overall solution more practical.

The evolution of water treatment is in a critical stage due to limited water sources and increasing need for water. Complex procedures are being formatted and used by chemical engineers to enhance the quality of water around the world before and after pollution is emitted into water systems. It is clear that the versatility of chemical engineering is an advantage in the extensive process of water treatment. The problem solving skills of engineers in this field will reflect in the progress of water quality around the world. With the help of creative and dedicated engineers, society is faced with less tantalizing global issues.

References

1. "Generating Energy." *Chemical Engineers in Action: Innovation at Work*. N.p., n.d. Web. 17 Sept. 2014. http://chemicalengineering.org/energy/index.html.
2. "What Can I Do with a Chemical Engineering Degree?" *Renewable Energy World*. N.p., n.d. Web. 17 Sept. 2014. http://www.renewableenergyworld.com/rea/blog/post/2012/10/what-can-i-do-with-a-chemical-engineering-degree.
3. "Chemical Engineers in Action: Innovation at Work." *Chemical Engineers in Action: Innovation at Work*. N.p., n.d. Web. 17 Sept. 2014. http://www.chemicalengineering.org/enviro/water.html.
4. "Chemical Engineering." *Chemical Engineering*. N.p., n.d. Web. 17 Sept. 2014. http://www.h2oz.org.au/Take-The-Plunge/Job-Category---Engineer/Chemical-Engineers.aspx.

Using Inherently Safer Design to Reduce the Risk of Terrorist Attacks

By: Zach Behrendt

September 11, 2001 is a day that made security a prime concern for the United States. When terrorists crashed into the World Trade Center, the government's main concern would be if and where the next attack would take place. They believed that chemical plants that make or store hazardous materials would be on top of the terrorists' list, and could do irreparable damage. The Government Accountability Office (GAO) has estimated that an attack at any of the 123 most vulnerable chemical plants could lead to injury or death of more than a million people. The Department of Homeland Security (DHS) implemented chemical facility anti-terrorism standards (CFATS) in 2007 to increase security in and around chemical facilities. While CFATS increased the safety to the threat of attack, a chemical plant can make changes so they are not as high of targets for terrorist activity. These changes can be made through Inherently Safer Design (ISD) that utilizes passive risk management strategies for a non-hazardous situation after unacceptable deviation. This would decrease the need for higher security from CFATS. Therefore, ISD should be required to protect America (Bollinger, 1996).

It is impossible to protect a plant from a terrorist attack 100% of the time; however, the effects of an attack can be greatly minimized by using ISD. ISD is a strategy to minimize the number and effect of a deviation from normal operating conditions (Bollinger, 1996). ISD uses a checklist to meet those goals: minimize, substitute, moderate, and simplify. An example is having hazardous materials made for demand instead of having large amounts of hazardous materials being stored and transported in large quantities. This minimization of hazardous materials on hand was not the case for the Bhopal disaster that took over 2,000 lives. If a terror attack were to occur against a chemical plant that made a hazardous material on demand versus large quantities on hand, smaller amounts of the hazardous chemical would be released to harm the people (Bollinger, 1996).

The idea behind ISD is to eliminate or reduce hazards by changing processes or materials or conditions which are non-hazardous or less hazardous. Integrating it into the product, process, or plant is not easily done without altering the process or plant design. An example of making the workplace safer is by substituting water for a flammable solvent. Another is using latex paints instead of oil base paints, which can be set on fire. Inherent design strategies often involve changes to basic process chemistry and unit operations. It is best to be considered as early in process development as possible, but it is never too late to implement them (Center for Chemical Process Safety, 2008).

As mentioned, the four strategies to ISD's are substitution, minimization, moderation, and simplification (Center for Chemical Process Safety, 2008). Substitution is when a less hazardous reaction is used or replacing a hazardous material with a less hazardous alternative. Although safer reactions may consume more materials and use more steps which decrease yields, it is more important to maintain a safe work environment. It is also important to minimize reactor sizes, pipeline inventories, and line length. An example of moderation is diluting hazardous solvents to decrease how much damage they can do. Finally, possibly the most important, is to simplify and eliminate unnecessary complexity in order to reduce the risk of human error. There is a popular and famous phrase: "Keep it simple, stupid" (KISS), which is used in many workplaces to reinforce the idea of not making things too complicated and therefore more dangerous. The most important to ask is "Is it really necessary?" (Center for Chemical Process Safety, 2008).

Technology that makes a process useful, also makes it hazardous, such as an airplane traveling at 600 mph, gasoline being flammable, and chlorine being toxic. Control of the hazard is the important issue for safely extracting the benefits of the technology. Most things have multiple hazards and any change can affect everything. Inherently safer is in the context of one or more of the multiple hazards. Different populations may perceive ISDs

Using Inherently Safer Design to Reduce the Risk of Terrorist Attacks (continued)

of different technologies differently (Center for Chemical Process Safety, 2008).

Not everyone is in agreement with implementing ISD, such as Society of Chemical Manufactures and Affiliates (SOCMA). SOCMA criticized the Secure Chemical Facilities Act that would require ISD. Bill Almond, vice-president of SOCMA, testified before the House Energy and Commerce Committee's Subcommittee on Environmental and the Economy, on Mar. 31, 2011, "[IST] is an elegant concept, but the reality is almost never that simple" (Van Arnum). He also stated that there is no agreed upon methodology to distinguish the safer process. He is employed by chemical manufacturers and is looking out for their interests, which include keeping the cost of doing business constant, and to not increase public safety (Van Arnum).

A debate still rages on with respect to an ISD mandate to protect the public from chemicals being utilized right in their backyard. With ISD employed, the effects of a terrorist attack would be reduced. One of these effects include releasing hazardous chemicals into the environment, ultimately defeating the goal of the attack. Some would say that this is just another unnecessary governmental regulation that chokes business. However, the real goal is to protect those who cannot protect themselves. Therefore, ISD should be mandated in all high risk chemical plants.

References

Bollinger, R. E. (1996). *Inherently Safer Chemical Processes: A Life Cycle Approach.* CCPS Concept Book.

Center for Chemical Process Safety. (2008). *Inherently Safer Chemical Processes: A Life Cycle Approach.* Wiley.

Van Arnum, P. (n.d.). *SOCMA Voices Concern over IST Provisions in Chemical-Site Security Measures.* Retrieved April 18, 2015, from http://license.icopyright.net/fuid=MTIzNTEwODI=.

Accounting Standards to Help Chemical Regulators

By: Alexandra Bartlett

The U.S. chemical manufacturing industry touches almost every portion of daily life. Last year, the industry reported revenue of $46.0 billion (Witter, 2015). Due to the chemical industry's diverse operations and potential impact on the health of the population and the environment, the industry is regulated by the 1976 Toxic Substances Control Act (TSCA). Recently, there have been calls for changing and updating the TSCA to reflect comparable legislation in the European Union. One solution to update the U.S.'s legislation is to adopt a codified standard that would have three organizations with clear authority over the chemical regulations.

While the TSCA put the Environmental Protection Agency (EPA) in charge of regulating chemical substances, the government agency has had difficulty using its regulative authority. The TSCA granted the EPA the "authority to require reporting, record-keeping, and testing requirements, and restrictions relating to chemical substances and/or mixing" (Environmental Protection Agency, 2014). However, the EPA must prove to companies that chemicals to be tested are harmful, which makes it difficult to obtain a comprehensive analysis of the chemical industry.

In the European Union, REACH—Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH)—controls the chemical production impact on the health of the humans and environment. Under REACH, the European Chemicals Agency was established to oversee the management of the "technical,

Accounting Standards to Help Chemical Regulators (continued)

scientific, and administrative" parts of the regulation (European Parliament, 2007). The European Union will protect the trade secret chemicals to support a competitive business environment while attempting to have companies share as much information as possible to establish a rigorous and transparent risk assessment. While the TSCA also tries to keep trade secrets confidential, companies can petition for non-disclosure of information outside health and safety, which limits the usefulness of the EPA's studies (American Chemistry Council, Inc., n.d.). U.S. lawmakers and chemical corporations have turned to the E.U.'s regulation of chemical companies for inspiration to change the outdated TSCA.

According the Government Accountability Office (GAO), five groups regulating the chemical industry have established laws that have resulted in fragmentation and overlap of risk assessment. The five agencies assessing chemical risk are the Agency for Toxic Substances & Disease Registry, the EPA, the National Institute for Occupational Safety & Health Agency, the National Toxicology Program and the Occupational Safety & Health Administration. While there is no duplication, variances between the government agencies arise because each agency uses a different scale. For example, the value deemed safe by the EPA for hexavalent chromium is for chronic exposure throughout a lifetime while NIOSH's standard considers exposure for 40 hours per week. These differences in safety values makes it difficult to compare safety standards from the various entities, which can differ by orders of magnitude (Zach System, 2014). With varying standards, it makes following the regulations as well as comparing values across agencies a challenge (Erickson, 2014). The 2013 Chemical Safety Improvement Act (CSIA)—a bipartisanship piece of legislation—aims to reform the TSCA. Reforming the 1976 legislation has been supported by the American Chemistry Council, who projects the new legislation to provide a $1.2 B yearly increase to U.S. chemical exports (Zach System, 2014). The goal of the new legislation is to have the EPA prioritize screening, to require safety testing, and to determine the safety of chemicals. This bill also clarifies what information is considered confidential business information (American Chemistry Council, Inc., n.d.). This piece of legislation does not change the scope of TSCA but rather encourages a more thorough inspection of the safety of the materials.

To assist in the reformation of the regulations, a single government entity in charge of regulating chemical manufacturing and importing should be created. Present-day struggles with fragmentation are similar to what the accounting world faced about a decade ago. Following changes in regulation, the U.S. Securities and Exchange Commission (SEC) has an ultimate authority over decisions on how public companies prepare financial statements, but the Financial Accounting Standards Board (FASB), a private-sector organization, establishes the standards of accounting and the Public Company Accounting Oversight Board (PCAOB) sets the standards for auditing (Revsine, Collins, Johnson, Mittelstaedt, & Soffer, p. 20, 2015). FASB's codification allowed for irregularities and problems to be recognized quickly and it has made it easier to compare the accounting data from U.S. firms to global firms. For the chemical industry, the EPA could imitate the SEC's position. A private organization, like FASB, comprised of chemical and safety experts would test chemicals and establish reasonable hazard limits. By being able to assign these responsibilities to one company, there would be a decrease in tax payer money spent on confusing standards, problems with chemical regulations would be fixed faster as no conversions between agency data would be needed, and the chemicals could be more comparable to those in Europe. Occupational Safety and Health Administration could check the safety and hazards in a manner similar to PCAOB. This additional check would provide a thorough picture of the workplace effects of the chemicals. Having three powers charged with the regulation process will eliminate unnecessary fragmentation and provide the public with a clearer picture of the health and environmental effects of the production of chemicals.

To eliminate confusing or contradictory regulations, the reformed TSCA should focus on employing a single source for hazard limits. FASB codified the standards for accounting and created a single database with all authoritative rule

Accounting Standards to Help Chemical Regulators (continued)

condensed from older standards (Revisine et al., p 22, 2015). By creating a single database, public and private companies have a single authoritative source for reference, which makes the financial statements a more faithful representation of the firm's performance as well as more relevant to decision making. FASB broke down the rules into topics, subtopics, sections, and subsections to help provide guidelines that fit the diverse operations of all companies that are publicly traded in the U.S. The TSCA inventory could evolve into what FASB created if the EPA's assessments are taken as the supreme rule in the United States and conditions for exemptions are clearly defined. If a single database is created along with the passage of the CSIA, then the EPA would promote transparency, increase comparability, and add relevance to the chemicals regulations.

Adapting the CSIA would increase the EPA's authority over the regulation. To eliminate confusion, the U.S. should have three groups rather than five agencies in charge of all aspects of chemcial regulation: the EPA as the final decision maker, a private organization similar to FASB that sets standards, and OSHA as the auditor. Three organizations would make it easier to keep the regulation uniform throughout the U.S., which will help global companies more likely to operate safely within the U.S. Decreasing the fractured nature of chemical regulation will help make the U.S. safer by reducing the confusion for the government, businesses, and the public.

References

American Chemistry Council, Inc. (n.d.). *CSIA Fact Sheet*. Retrieved February 15, 2015, from ReformTSCA.com: http://reformtsca.com/

Environmental Protection Agency. (2014, July 10). *Summary of the Toxic Substances Control Act*. Retrieved February 15, 2015, from United States Environmental Protection Agency: http://www2.epa.gov/laws-regulations/summary-toxic-substances-control-act

Erickson, B. E. (2014). Overlapping Toxicity Efforts. *C&EN Washington*, 29-30.

European Parliament. (2007). Corrigenda to Regulation No1907|2006. *Official Journal of the European Union*, 1-8. Retrieved from Official.

KPMG. (2010). *The Outlook for the US Chemical Industry.* Retrieved February 15, 2015, from KPMG: http://www.kpmg.com/US/en/IssuesAndInsights/ArticlesPublications/Documents/us-chemical-industry-outlook.pdf

Revsine, L., Collins, D., Johnson, W. B., Mittelstaedt, H. F., & Soffer, L. C. (2015). *Financial Accounting & Analysis.* New York: McGraw-Hill Education.

Witter, D. (2015, February). *Chemical Product Manufacturing in the US*. Retrieved February 15, 2015, from IBISWorld: http://clients1.ibisworld.com.proxy.lib.uiowa.edu/reports/us/industry/currentperformance.aspx?entid=503

Zach System. (2014). Overlapping Toxicity Efforts. *Government Policy*, 29-30.

Innovation in Chemical Engineering: The Frontier of Targeted Chemotherapy

By: Katherine Giles

Chemical engineering has played a fundamental role in creating the technological and medical advances that society depends on today. From food safety to better energy sources, chemical engineers have applied scientific advances to create products that serve people across the world. In particular, chemical engineering principles and skills have been applied to biomedical challenges. This multidisciplinary approach to modern medicine has led to invaluable large scale health solutions like vaccines, antibiotics, and other chemical therapies for diseases (1). One area in the health field in need of innovation is cancer, which affects millions of Americans every year. Advances in cancer chemotherapy treatment and technology must be developed by chemical engineers to fight this disease in the near future.

Cancer is defined as the uncontrolled growth and spreading of abnormal cells (2). In the United States it is currently the second leading cause of death and nearly 1.7 million new cases are expected to be diagnosed in 2014 (3). One of the most common treatments for all types of cancer is chemotherapy, which uses chemicals to kill and control cancerous cells. Current chemotherapy treatment involves high risk and unwanted side effects. Blanket chemotherapy, in which the drugs are applied to the entire body, is the most common form of chemotherapy; it endangers healthy cells around the cancerous ones because the cancer drugs aren't targeted closely enough. Doses of chemotherapy also lead to side effects including hair loss, nausea, weight loss, fatigue, and infertility (3). Chemotherapy needs improvement in order to offer more effective, less harmful cancer treatment. The task of improving the precision and delivery of cancer drugs, or targeted chemotherapy, falls to chemical engineers.

From a chemical engineering perspective, chemotherapy can be viewed as a chemical process and the drug delivery device is a system. Ideally, cancer drugs would pass through the body in a protective carrier until they encounter the cancerous cells, at which point the drugs would be released in a more focused dosage. Since chemotherapy involves such toxic drugs, improving the release of these drugs to a more controlled target area of the body would lead to minimized dosages, and therefore more manageable side effects.

Drug delivery systems that may lead to targeted release for chemotherapy are currently being researched by scientists around the world. Some of the most promising research involves nanotechnology. Nanotechnology can be implemented to delay the release of cancer drugs until they reach the targeted organ or cells, at which point a trigger of temperature, pH, or magnetic stimulation would initiate treatment at the site (1). Nanoparticles have unique properties, such as small size and surface area, that allow them to overcome the body's drug resistance and improve chemotherapy effectiveness (2). Promising release methods include hydrogels that can be loaded with medicine and are stable in acidic environments, allowing chemotherapy to travel to the cancerous area before activating (1). Additional forms of drug delivery include fullerenes, which are large enough to resist attack from the body while carrying cancer drugs, reducing cell damage and unwanted side effects (4). Chemical engineers must produce and standardize procedures using these forms of nanotechnology to develop more effective chemotherapy treatment.

Cancer is an unforgiving disease that affects millions of people at some point in their lives. Improving chemotherapy is vital to address the growing number of diagnoses each year. In the near future, chemical engineers must harness research breakthroughs in drug delivery methods such as nanotechnology to produce controlled release mechanisms for chemotherapy. These mechanisms must then be optimized for targeted treatment and produced on a larger scale to cut down on cancer mortality, improve the quality of life for cancer patients through minimized chemo side effects, and cure cancer more effectively. Chemical engineers can change modern medicine and help millions of people fight-- and beat-- cancer.

References

1. Lederman, P. American Institute of Chemical Engineers (2009).
2. Cancer Treatment and Survivorship Facts and Figures 2014-2015. American Cancer Society (2014).
3. Feng, S., & Chien, S. Chemical Engineering Science **58** (18), 4087 (2003).
4. Riyaz, B., Nirupama, S.,

Innovation in Chemical Engineering: The Frontier of Targeted Chemotherapy (continued)

Heym, K., Bowman, W., & Lacko, A. G. Frontiers In Oncology **41**, 4 (2014).

TSCA Reform

By: Christopher Brown

Today nearly twenty-five percent of the U.S. gross domestic product is derived from industries that rely on chemicals (1). With an ever-expanding chemical industry, the United States government is under substantial pressure to update and reform its outdated chemical safety law. According to the National Resources Defense Counsel, there are more than 80,000 chemicals that are available in the United States that have never been fully tested for their toxic effects on human health and environment (2). It is evident that the United States chemical safety law needs modernizing, but choosing the correct approach may prove to be somewhat difficult. The purpose of this text is to provide an adequate approach to improving the laws and legislations surrounding chemical safety in the United States.

The current law on chemical safety is titled the Toxic Substances Control Act (TSCA), and it has not been updated since it became a law in 1976 (1). The TSCA was originally created to ensure the safety of chemicals from manufacturing, to use and disposal. Once passed, the TSCA provided the U.S. Environmental Protection Agency with the authority to require reporting, record keeping and testing requirements, and restrictions relating to chemical substances. According to Michael Wilson, the Director of the School of Public Health at the University of California, there are three 'gaps' related to the approach taken by the TSCA: the data gap, which states that chemical producers are not required to investigate or disclose sufficient information on the hazardous traits of chemicals; the safety gap, which states that even when hazard and exposure information are robust, government is stymied from taking action by TSCA's high standard of evidence; and the technology gap, which refers to a lack of clear regulatory framework to support making safer chemicals (3).

Other countries have already taken steps to further chemical safety within their infrastructure. For example, Europe passed the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) legislation in June of 2007. Under the REACH legislation all manufacturers and importers of chemicals are required to identify and manage risks linked to the substances they manufacture and market. If a company imports or produces one ton or more of a substance in a year, then they are required to submit a registration to the European Chemical Agency; failure to register a substance results in that substance not being able to be imported or produced by that company. Once a substance has been registered with the European Chemical Agency, it is evaluated for risks to human health and the environment. If a substance is identified as being a high risk, then it will be put on a 'candidate list' and eventually will be restricted from being placed on the market (4).

The United States currently has a single proposed legislation to reform the TSCA. The Chemical Safety Improvement Act, or CSIA, was proposed by a bipartisan group of senators with the intention of improving the current chemical safety law. A few notable changes to the TSCA are the mandating of safety evaluations for all chemicals in active commerce, making more information regarding chemicals available to the public, allowing the EPA to require testing without first having to show potential risk, providing the EPA with adequate resources to complete their tasks, and requiring new chemicals to be deemed 'likely safe' before entering the market (5). This legislation was proposed in 2013 and has yet to pass, although many remain hopeful.

A comparison of the two approaches discussed, the REACH and CSIA legislations, reveals that both have potential for improving chemical safety in the United

TSCA Reform (continued)

States. I like the REACH legislation because it puts more responsibility on the manufacturers and importers of chemicals; however, I feel this approach may create tension between the manufacturers, which will have to now spend more money on testing, and the government. I also prefer the CSIA legislation because it gives the U.S. EPA the authority to require the testing of any chemical; I was alarmed to learn that the TSCA required the EPA to show that a chemical posed potential risk before they could require testing. Both legislations seem to promote the research and production of safer chemicals, which I believe to be a necessary component of a successful safety program. In my opinion, I think the best chemical safety legislation for the United States should be structured similar to the REACH program, while giving the EPA the same authority as the CSIA legislation. The reasoning behind my choice is that the REACH program follows a very simple, structured, process for maintaining chemical safety, while the CSIA legislation allows the EPA the authority needed to get information to the general public regarding the safety of the chemicals that we may be exposed to. By implementing the changes described above, I believe the chemical safety in the United States would be greatly improved. There would no longer be such a large quantity of chemicals being distributed without proper testing, and the public would have adequate information regarding the safety of these chemicals.

References

1. "Chemical Safety Improvement Act." Reform TSCA. American Chemistry Counsel, 1 Jan. 2014. Web. 16 Feb. 2015. http://reformtsca.com/Main/CSIA-Fact-Sheet.pdf
2. "NRDC: Protecting People from Unsafe Chemicals." NRDC: Protecting People from Unsafe Chemicals. National Resource Defense Counsel, n.d. Web. 15 Feb. 2015. <http://www.nrdc.org/health/toxics.asp>.
3. Venables, K. M. "Mortality in British Military Participants in Human Experimental Research into Chemical Warfare Agents at Porton Down: Cohort Study." BMJ: British Medical Journal 338.7697 (2009): 749-53. Berkeley.edu. University of California, Berkeley. Web. 16 Feb. 2015. <http://eucenter.berkeley.edu/files/SchwarzmanWilson_Medicine%20book%20chapter.pdf>.
4. "Restrictions." REACH. European Commission, 21 Nov. 2014. Web. 16 Feb. 2015. <http://ec.europa.eu/enterprise/sectors/chemicals/reach/restrictions/index_en.htm>.
5. "Chemicals Policy Reform." Environmental Defense Fund. Environmental Defense Fund, n.d. Web. 16 Feb. 2015. <http://www.edf.org/health/policy/chemicals-policy-reform>.

Chemical Engineering Spotlight

Class of 2016

The Best Approach to Chemical Regulation in the United States

By: Marlis Owen

The Agency for Toxic Substances and Disease Registry (ATSDR), the Environmental Protection Agency (EPA), the National Institute of Occupational Safety and Health (NIOSH), the National Institute of Environmental Health Sciences (NIEHS), the National Toxicology Program (NTP), the U.S. Centers for Disease Control and Prevention (CDC), the Occupational Safety and Health Administration (OSHA), and state agencies are all responsible in some way for regulating chemicals in the United States (Erickson, 2014). This complicated system of regulations has chemical industry groups concerned with the effectiveness of the overlapping multi-agency approach, and many are calling for an update to such legislation as the Toxic Substances and Control Act (TCSA). This law, after decades of implementation by the EPA, stands outdated and contradictory. Now is the time for the United States to consider reorganization of its chemical regulation agencies for better enforcement of laws that uphold public health and safety, protect the environment, and encourage innovation.

TCSA allows the EPA to regulate the distribution and use of chemicals, but the current system needs reform to reflect scientific advancements and the interests of stakeholders (TSCA Modernization, 2015). With Republicans now controlling both chambers of Congress, a reform bill is more likely to pass. However, opponents are concerned that a new federal law would nullify the states' authority over chemical control (Erickson, 2015). Regardless of philosophies about state versus federal power, legislation must address the need to establish a transparent system for prioritizing chemicals to reduce regulatory burdens on businesses and improve confidence in the American chemical management system. These goals can be accomplished with TCSA reform while ensuring legislative stability and predictability for businesses.

In addition to TCSA reform, congressional lawmakers and chemical industry groups are calling for the consolidation of hazardous chemical assessments into one federal agency. Currently, a long list of agencies evaluate many of the same chemicals to satisfy many of the same goals in a web of policies and rules. Driven by laws with different requirements, multiple agencies may evaluate the same chemicals, but their efforts are fragmented, overlapping, and not duplicative (Erickson, 2014). Contradicting values of safety standards and toxin exposure limits among the different agencies further exacerbate the confusion about chemical safety. Clearly, the United States needs a more unified and efficient approach.

Overhauling the current system to create a single federal chemical regulation agency is a daunting task, but the need to protect confidential business information (CBI) and intellectual property makes collaboration among multiple agencies impossible (Erickson, 2014). With just one chemical regulation agency in the United States, publication and distribution of public safety information would be less hindered by laws protecting businesses' proprietary information without sacrificing American capitalism and innovation. This change would benefit the chemical industry by increasing its accountability and reducing the time and money businesses spend satisfying the requirements set by multiple agencies.

To aid this transition, the United States can look to the European Union Registration, Evaluation, Authorization and Restriction of Chemicals (EU REACH). This legislation streamlined and improved the chemical regulation framework in the European Union when it became law on 1 June, 2007 by making "industry responsible for assessing and managing the risks posed by chemicals and providing appropriate safety information to their users" (How does REACH, 2013). Authorities control substances that are manufactured or imported in quantities above a metric ton, while identifying, evaluating, and restricting use of high-priority chemicals. The European Commission acknowledges areas of weakness, but they are confident in the success of REACH and optimistic that improvements will be made.

As a member of the global chemical market, the United States has already benefited from EU REACH. The imminent reform of our own chemical regulation, namely the modernization of TSCA and the consolidation of chemical risk assessment efforts will improve the safety, health, and welfare of American citizens and businesses. TSCA reform will reflect technological advancements, improve the categorization of chemicals, and raise confidence in America's chemical regulation system. To improve efficiency and allocation of the government's resources, chemical risk assessments ought to be consolidated, with the added benefits of reducing regulatory burdens on businesses and increasing their accountability. These changes are necessary for the safety and continued prosperity of the chemical process industry.

References

Erickson, B. E. (2015). Congressional Outlook 2015. *Chemical & Engineering News*, 93 (3). cen.acs.org/articles/93/13/Congressional-Outlook-2015.html.

Erickson, B. E. (2014). Overlapping Toxicity Efforts. *Chemical & Engineering News*, 29-30.

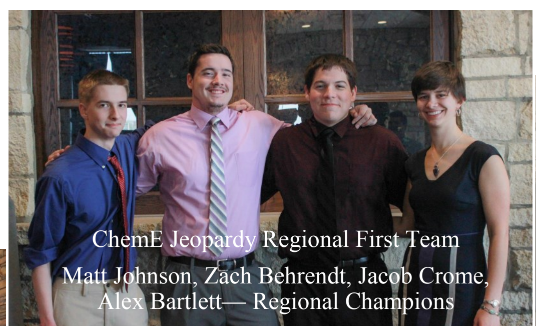
How does REACH work? - Chemicals - Enterprise and Industry. (2013). Retrieved from ec.europa.eu/enterprise/sectors/chemicals/reach/how-it-works/index_en.htm.

Toxic Substances Control Act (TSCA) | Agriculture | US EPA. (2012). Retrieved from www.epa.gov/oecaagt/lsca.html.

TSCA Modernization | TSCA Regulation | TSCA Reform. (2015). Retrieved from www.americanchemistry.com/Policy/Chemical-Safety/TSCA.

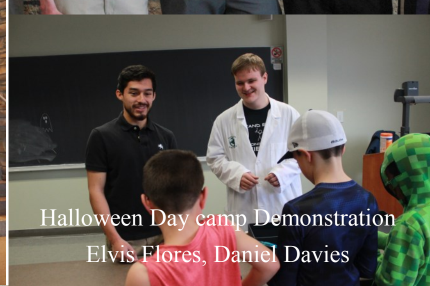
Chemical Engineering Spotlight


Halloween Day camp Demonstration
Kayla Racinowski


ChemE Jeopardy Regional First Team
Matt Johnson, Zach Behrendt, Jacob Crome, Alex Bartlett— Regional Champions


Research poster presenters at the 2015AIChE regional conference
Matt Johnson, Edwin Sagastume, Lu Liu, Michael Anderson, Kathryn Classon


ChemE Jeopardy Regional Second Team
Daniel Davies, Marlis Owen, Elvis Flores, Nathan Schuchert


Halloween Day camp Demonstration
Elvis Flores, Daniel Davies


Social Event


University of Iowa Attendees to the 2015 AIChE Regional conference


Congratulations to the class of 2015!

Acknowledgements

Thank you to the AIChE Officers for their hard work and contributing efforts to make our AIChE Student Chapter a successful organization.

Fall 2014 OFFICERS:

President: Spencer Zook
Vice President: Anthony Miller
Secretary: Kayla Racinowski
Treasurer: Elvis Flores
Newsletter Editor: Adam Erickson
Webmaster: Danny Yocius
Historian: Sarah Goettler
Fundraising Chair: Anna Rawerts
Social Chair: Val Renkor
ChemE Car Chair: Adam Johns

Spring 2015 OFFICERS:

President: Anthony Miller
Vice President: Elvis Flores
Secretary: Kayla Racinowski
Treasurer: Alexandra Bartlett
Newsletter Editor: Jenna Stoltzfus
Webmaster: Nathan Schuchert
Historian: Sarah Goettler
Fundraising Chair: Valerie Renkor and Jenna Stoltzfus
Social Chair: Valerie Renkor
ChemE Car Chair: Adam Johns

Editor-In-Chief Jenna Stoltzfus would also like to thank the following people for their support and contributions to the Fall 2014/Spring 2015 AIChE Student Chapter Newsletter:

Faculty Advisor: Prof. David Murhammer

Contributors: Anthony Miller, Joe Warmuth, Jeff Hamilton, Shandy Porter, Nathan Schuchert, Maliah Kome, Abby Haas, Zach Behrendt, Alexandra Bartlett, Katherine Giles, Christopher Brown, Marlis Owen

Your help is much appreciated!

Interested in speaking at professional seminar? If so, then contact AIChE Student Chapter President at Kalya-racinowski@uiowa.edu or Student Chapter Advisor Prof. David Murhammer at david-murhammer@uiowa.edu for details and availability!

THE UNIVERSITY OF IOWA