The University of Iowa

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AIChE Spring 2018

Advisor's Corner

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

Greetings to Hawkeye Chemical Engineers!! This Spring 2018 issue of our AIChE Student Chapter Newsletter begins with articles about our student chapter's attendance at the 2018 AIChE Mid-America Regional Conference and our ChemE Car. This year's regional conference was held at Oklahoma State University in Stillwater, OK on April 20th and 21st. I attended the conference with 24 of our undergraduate students. Our student chapter was very active at the conference with a participating ChemE Car team led by Jenny Stevenson, four students giving oral research presentations in the paper contest, one student given a research poster presentation and two competing ChemE Jeopardy teams. Ojas Pradhan was awarded 3rd place in the paper contest and one of our ChemE Jeopardy teams (Megan Jones, Elizabeth Zimmerman, Madison Murhammer and Zachary Kazmer) won the competition and will be representing the Mid-America Region at the national competition being held late October in Pittsburgh, PA.

This Newsletter issue also contains articles about (i) the Earth Day themed day camp that was held on April 15th for K-5 children, (ii) an undergraduate research experience, (iii) a co-op experience, (iv) participation in the India Winterim program and (v) three article related to chemical plant security and two articles about chemical regulation that were requirements for our Chemical Process Safety course.

Any comments about the newsletter contact can be sent to me at david-murhammer@uiowa.edu.

University of Iowa American Institute of Chemical Engineers

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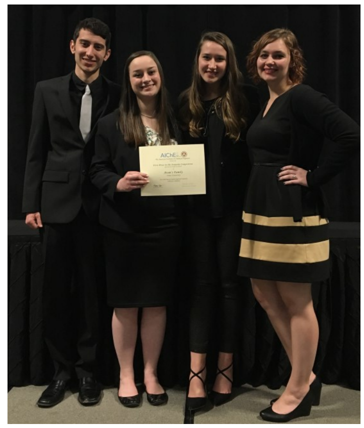
AIChE THE UNIVERSITY OF IOWA

AIChE Regional Student Conference - Christine Czarnecki

On the weekend of April 20th-April 22nd, the University of Iowa student chapter of the American Institute of Chemical Engineers took a trip to Oklahoma State University for the Regional Student Conference. The conference began with a meet and greet with the other student chapters and companies such as Texas Instruments. The following morning started early with the ChemE car competition. Our chapter brought a car to the competition, and although we did not advance to compete in the National Conference, we plan to improve our car and come back better than ever next year. Numerous students participated in the poster and paper presentations for the research they participate in on campus. Ojas Pradhan won third place in the paper competition, presenting his research on The Formulation and Analysis of Novel Dry Powder Antibiotic Aerosols. In addition, our ChemE jeopardy team won first place and will be advancing to compete at the National Conference! The members of this team are Megan Jones, Lizzy Zimmerman, Madison Murhammer, and Zach Kazmer. We look forward to the National Student Conference in Pittsburgh, Pennsylvania in October 2018.



ChemE Car - Jennifer Stevenson

A car finally has made it to the starting line for the Regional Conference for the first time since 2014. Did the car move? No, but the entire process has been a learning experience for what to expect for future car production. The car construction faced many different trials and tribulations from being set back two months from changing labs to resources running low, but in the end, we prevailed.

Chem E Car is a competition at the Regional and National Conference for AIChE that allows for national and international competition. The car is to run and stop solely based on chemical reactions. There are many different combinations that schools use from pressure cars to lead acid batteries. The cars are to travel a set distance while carrying a given amount of water. The distance and amount water are given one hour before the competition begins. For the Mid-America region, the top three cars that are closest to the desired distance advance to Nationals.

There were seven main students working on the car itself. The build of the car was constructed from wood for the base then a plastic layer was secured onto wooden platforms with a hinge in the center to allow for easy access to the motor. The starting mechanism of the car was created by use of an aluminum air battery. The battery produced a speed with the motor of 1 ft/s. The stopping mechanism of the car was an iodine clock reaction. The reaction worked to stop the car by turning from a clear solution to black. The reaction was conducted between two light sensors that were programmed to stop the motor once the reaction is complete. In the end, the processes all came together for the final product.

The car did not progress far, but the Chem E Car team has made leaps and have new plans for next year to compete again. With our new insight into the competition itself, we have plans to start fresh and make it to Nationals next year!

Kids Day Camp - Annemarie Weber, Hannah Wasserkrug, Mackenzie Cady

On Sunday, April 15th, the University of Iowa's AIChE student chapter hosted their semi-annual Kid's Day Camp for kids from Kindergarten through fifth grade. The camp's focus is to give a basic level introduction of chemical engineering by doing simple chemistry and science experiments. The children were able to participate in five different activities that went along with the Earth Day theme. The first experiment consisted of making lava lamps out of full-sized plastic water bottles. The participants were able to make their lava lamp whatever color they wanted with different food coloring, and they were able to add glitter to give the lava lamps a little more pizazz. This activity allowed them to learn about the densities of different liquids, such as water and vegetable oil, which were used during this experiment

The next activity that the children participated in was a simple craft using egg cartons. Each participant received one round piece of a cardboard egg carton and was allowed to paint any insect that they wanted. Popular designs were lady bugs and bumble bees. Following the art craft, it was finally snack time. For snack the children were allowed to make dirt cups, which consisted of chocolate pudding, crushed Oreo crackers, and gummy worms. The alternating layers of chocolate pudding and crushed Oreo crackers allowed the children to learn about the different layers of the Earth, with the gummy worms in the top layer, representing all the insects that help nourish the top soil. After snack time, the participants made mini volcanos using baking soda and vinegar. During this time the children learned about natural disasters and why they occur. The last and final activity for the Earth Day themed day camp consisted of planting either flowers or tomatoes in decomposable pots. This allowed the kids to learn about the importance of planting. The camp was very successful, and the kids had a lot of fun. We look forward to the next Kid's Day Camp, which will take place in the Fall of 2018, with a Halloween theme.

My Research Experience - Ojas Pradhan

When I came to the University of Iowa, I knew that I wanted to conduct research. I was eager to get involved in a lab as soon as I could. As a freshman, I was interested in nanotechnology and its application to medicine. After learning more about the faculty in the chemical engineering department, I joined Dr. Jennifer Fiegel's lab. Her lab deals primarily with developing new drug delivery methods for lung infections. In my first 2 years in the lab, I learned a lot about the unique challenges associated with lung infections and the techniques we used to combat these infections. In particular, I learned how to use a technique called spray drying which creates fine powders from a feed solution. We are interested in using this method to create inhalable, dry powder versions of antibiotics that can directly deliver the drug to the infected region of the lung. Direct delivery is incredibly useful in lung infections since the drug does not get metabolized by the body before reaching the affected area. This also reduces the likelihood of any dangerous side effects from the drug itself since the drug is only taken up by the bacteria.

An important consideration for creating powders for the lungs is their size. If powders are too big, they can get stuck in the throat or the upper lung. If they are too small, they might be breathed out without ever getting stuck in the right part of the lungs. Our current project is focused on developing spray dried powders that have a favorable size distribution to ensure that the drug gets to the infected region of the lungs. We can test the size distribution using a Next Generation Impactor (NGI). An NGI is essentially a series of trays with a series of smaller and smaller filters over them. By flowing powder through the filters, we can figure out what the size distribution is based on where they deposit on the trays. By mapping the trays to parts of the lung, we can develop a mechanical analog for the lungs. We are currently in the process of developing a suitable method for measuring the deposition on the trays using high-performance liquid chromatography (HPLC).

Working in the lab has been an invaluable experience. I've learned how real experiments are designed and executed and learned how to communicate my work to a variety of audiences. As I finish my undergraduate degree over the next year, I hope to continue developing these skills by pursuing a Ph.D. in chemical engineering. Wherever that path leads me, I know that my time at Iowa will have been a key part of preparing me for my future.

U.S. Regulation on Inherently Safer Design Technology - Cassie Joyce

The Chemical Facility Anti-Terrorism Standards (CFATS) program established by the US Department of Homeland Security (DHS) is set to expire within 2018. To move forward, the program needs to be assessed for any adjustments that could improve country-wide safety protocol. Currently, chemical facilities that fall under the program have to analyze their plant risks, generate security plans, receive DHS approval, and implement the security measures (C&EN, 2018). To determine plant risks, engineers can utilize inherently safer design technology systems. A system that is inherently safe is one that maintains a nonhazardous status when there is deviation from normal operating conditions (Crowl & Louvar, 2011). Thus, inherently safer design technology is an analytical system that provides recommendations for a given manufacturing process to adopt inherently safe practices and strategies (Hess & Johnson, 2014). These strategies include minimize, substitute, moderate, and simplify, which all include recommendations to reduce risks in a given chemical process. With the range of recommendations from each strategy to improve the process, engineers can adequately adopt the safest methods. Moving forward with the CFATS program, all chemical facilities in the US need to ensure they have the utmost security and inherently safe processes. This way, if a terrorism act were to occur involving any given chemical plant, the potential for hazardous effects would

U.S. Regulation on Inherently Safer Design Technology (cont.)

be minimal because the highest safety protocol would already be in place. By requiring all chemical facilities to use inherently safer design technology systems, the US can be assured that the maximum safety procedures are in place and any potential acts of terrorism would cause minimal harm.

To start, requiring the use of inherently safer design technologies forces all industrial chemical companies that fall under this realm to participate in advanced chemical safety. Currently, all safety improvement efforts by a chemical company are completely voluntary. As stated by the Coalition to Prevent Chemical Disasters, "New requirements to implement inherently safer alternatives are necessary to achieve long-overdue hazard reduction that has not been achieved by voluntary measures" (Hess, Boosting Safety at Chemical Facilities, 2015). Since hazard reduction is only recommended and not required, it is up to the facility to take up safety measures on their own. Former EPA administrator Christine Todd Whitman agrees, "Many companies have acted responsibly, but far too many others have not" (Hess & Johnson, 2014). Based on current requirements, not enough chemical facilities are participating in the recommended safety protocol. For the companies already complying, great, keep up the good work! For those who have not put much thought into it, time to get started! To ensure that the entire chemical industry is operating at optimal safety standards, hazard reduction procedures need to be required. This way, all facilities in the US are operating at the same safety standards and hazard risk is reduced. The best way to incorporate adequate hazard reduction is through requiring inherently safer design technology.

In addition to requiring inherently safer design technology, the US should increase efforts to assist individual companies with compliance. For chemical safety regulations to make a substantial impact, they must be closely observed and managed. Not all chemical facilities will be able to directly accommodate the requirements. To ease this tension, the US should assist these facilities with compliance. The American Chemistry Council, the Society of Chemical Manufacturers & Affiliates, and the American Fuel & Petrochemical Manufacturers have banned together on a similar stance on this issue. They believe regulators need to focus on improving existing enforcement and compliance so all facility operators "understand and live up to their obligations" (Hess & Johnson, 2014). Although some groups believe requiring inherently safer design technologies would be redundant, they must be required to ensure that all chemical facilities are complying and not just the few that have voluntarily participated. By requiring it, all companies will have to analyze their process for any potential safety improvements and implement them. On top of the requirement of inherently safer design technology, it is essential for regulators to listen to the feedback from these chemical industry associations since they know more about the specifics of accommodating the regulations. Knowing this, it is critical for the US government to reach out to the current companies that either are not voluntarily performing hazard reduction or are having trouble doing so. This can be facilitated through extra funding or providing a contractor to help with the transition. With the additional hands-on assistance and funding, a facility can adopt and properly implement safety assessment programs such as inherently safer design technology.

To conclude, it is essential for the entire chemical industry to operate at the same safety standards to reduce accident hazards and the potential effects of an act of terrorism. In order to accomplish this, inherently safer design technology should be required at all chemical facilities. This ensures that each plant is analyzing and implementing the utmost safety procedures. With inherently safer design strategies in place, it can be confirmed that minimal damage will ensue if there is a mishap in the process or an attempted act of terrorism. In addition, regulators should assist chemical facilities in complying with the new regulation. Providing funding and contractors could assist the transition process for a facility to utilize inherently safer design technology. By requiring the ultimate chemical safety technology and guiding companies through the transition, chemical safety can be enhanced for years to come.

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A Model for Chemical Regulation in the United States - Adam Weis

What is the best approach for chemical regulation in the United States? With the recent updates to the Toxic Substances Control Act (TSCA) the U.S. has finally taken overdue action to modernize its chemical regulations and protect the health of its people and environment. However, while the updates to the TSCA help regulators enforce chemical regulations, this new TSCA is not the ideal system. American regulators are still bogged down by slow regulation procedures, companies are still allowed too much freedom in determining chemical status, and small businesses are forced to conduct expensive safety reviews at their own cost (Hogue, U.S. chemical regulation shifts, 2016). The U.S. should implement aspects of the European Union's Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) chemical regulation program, and collaborate with these countries to form an international chemical review. REACH requires companies to reveal all chemicals used, has a streamlined review process, and has proven to actually support innovation. In addition, regulators should be granted resources to help businesses conduct safety reviews and incentivize using safe alternative chemicals.

Many problems with the TSCA were solved in the updated version passed in 2016, but the system still lacks the efficiency and resources to make drastic changes while not hampering innovation. The old TSCA was essentially worthless since the U.S. Environmental Protection Agency (EPA) had virtually no power to enforce chemical regulations. They were required to choose the "least-burdensome alternative" when restricting the use of a certain chemical. This allowed companies to claim that EPA demands were "burdensome" and legally avoid compliance. The EPA can now demand companies comply without providing the easiest alternative (Hogue, Senate sends chemical safety legislation to Obama, 2016). Companies were also protected by trade secrets and didn't have to declare every chemical they were using, lest it jeopardize proprietary information. Claims of trade secrets have now been lifted so companies can no longer hide behind them (Hogue, U.S. chemical regulation shifts, 2016). Another issue with the old TSCA actually stemmed from individual states trying to enforce their own chemical regulations, albeit with good intentions. This led to a confusing mix of regulations between state lines and questions over the enforcement of state regulations. Now, the EPA handles all regulations and compliance, creating a more centralized and straightforward regulation process (Hogue, U.S. chemical regulation shifts, 2016).

Although the updated TSCA has improved chemical regulation in many ways, it still fails to modernize the U.S. system. Due to the lack of regulation over the past few decades, the EPA has to document and review thousands of chemicals. It will take an estimated 35 years before the updated TSCA takes full effect (Hogue, U.S. chemical regulation shifts, 2016). These long and expensive review processes also disproportionately hurt small businesses, since the rules require that each company conduct its own extensive safety reviews. While large chemical companies can easily afford this, smaller operations lack the resources (Hogue, U.S. chemical regulation shifts, 2016). Meanwhile, the new TSCA provides no direction for regulators suggesting alternative chemi-

A Model for Chemical Regulation in the United States (cont.)

chemicals, leaving research and development projects also up to the companies (Hogue, U.S. chemical regulation shifts, 2016).

Chemical regulation in the U.S. should collaborate with and model itself off of the E.U. REACH system. To avoid a generation's worth of chemical reviews under the new TSCA, the U.S. should share chemical safety data with the E.U., saving time and money. This collaboration would help both programs efficiently build a chemical safety database and streamline regulations. In addition, REACH requires that all companies document every single chemical made or imported by them, ensuring that all chemicals are subject to review. The looser TSCA does not require companies to report everything so some hazardous chemicals are missed for evaluation (Scott, 2016). Meanwhile, evidence suggests that innovation is not hampered by REACH and safe alternative chemicals have been found. Companies have applied for continued use of only 12 of 31 banned chemicals, implying that safe alternatives have been found for the others. Additionally, after a ban on phthalates, the number of patents for substitute chemicals increased from 1 to 20, an indication of strong innovation (Scott, 2016).

REACH is not without issues of its own, however. The financial constraint imposed on companies by chemical regulation has encouraged some companies to outsource to China and many small businesses complain about not being able to meet the new standards, the same issue faced in the U.S. A recent survey found that 35% of European companies say REACH has hurt operations and only 10% say it is a positive program (Scott, 2016). These issues could be resolved by affording regulators extra funds to help companies research and develop safer chemical alternatives. Subsidies or tax breaks could also be given to companies that promptly comply with new regulations, incentivizing compliance and funding further research. While strict safety standards are crucial for the chemical industry, companies will only stay in the U.S. and comply to the standards if their operations are not hampered. The EPA actively helping industry meet regulations is the best way to ensure that companies are able to succeed and use safer chemicals.

The U.S. should implement a hybrid of the updated TSCA and REACH, taking only the best aspects of both. An international registry of all industrial chemicals must be compiled to review safety data, streamlining the regulation process. As with REACH, companies must be required to reveal all operations to the EPA and comply with new regulations. To ensure that the new system doesn't hurt industry, funding must be granted to the EPA to conduct research into safer alternatives and provide subsidies to companies that comply. Chemical safety is more important than industrial success but if businesses are throttled by new regulations they'll be more likely to seek out loopholes, leading to dangerous business operations. A successful chemical regulation system must help companies find safer alternatives rather than just imposing regulations and waiting for industry to comply on their own.

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Safety: A Requirement of the Design - Ali Vaske

In recent years the number of disasters and near-misses in the chemical process industry has put immense pressure on politicians to reform safety acts. It is believed that enforcing inherently safer design could reduce the number of accidents and prevent injuries and fatalities in affected populations. Inherently safer design refers to designing a process in such a way that the amount of hazardous materials and operations is reduced. Inherently safer design practice is focused on eliminating the hazard rather than controlling it. This concept is one that most in the chemical industry have already adopted yet, as more avoidable accidents occur, some argue that inherently safer design should be enforced by law. However, enforcing inherently safer design would not be an easy feat and could have negative effects as it may result in higher risk in the transportation industry and inhibit ability to meet market standards.

There are four primary paths to inherently safer design: minimization, substitution, moderation, and simplification (Glenn Hess, 2014). Minimization refers to reducing the quantity of hazardous materials chemicals used in the process and the number of dangerous chemicals stored on site. This idea is based on a relatively simple principle; if the material isn't there to begin with, then it can't be released or fuel an explosion. Substitution refers to replacing the hazardous chemical with one that is less hazardous. Moderation and simplification apply to the process operation. Overall the process facilities should be designed to minimize the risk and impact of hazardous material releases. Typically manufactures reduce this risk by operating at low pressure and temperature. Finally, the process should be designed in a manner that diminishes unnecessary complexity. A lengthy or complex procedure is likely to generate a higher probability of human error that can result in a toxic release.

Inherently safer design is also an important concern for security. Tank farms that house hazardous materials can provide a means for a terrorist to harm a population. The Chemical Facility Anti-Terrorism Standards (CFATS) program was enacted the U.S. Department of Homeland Security (DHS) in 2007. The program requires that facilities that make, use, or store threshold quantities of any one of 300 hazardous chemicals must assess their risks and enact a DHS approved site-security plan (Hess, 2018). The CFATS program has been very successful and supported by many manufacturers. Kirsten Meskill, director of corporate security for BASF, states, “The CFATS programs has helped make our industry and communities more secured.”

Although inherently safer design could substantially reduce the number of accidents that occur in the chemical industry, many manufacturers still resist the idea of forcing the practice by law. One of the primary goals of inherently safer design is to reduce the quantity of hazardous materials utilized and stored on site. However, if facilities are required to reduce the amount of materials they have on-site the result would be increased transportation of the materials, shifting risk to different points along the supply chain and increasing the likelihood of loading, unloading, or in-transit incidents (Glenn Hess, 2014). The chemical industry is one of the safest industries in the U.S. whereas risk in transportation is much higher (Daniel A Crowl, 2015). Shifting the risk to the transportation industry could result in more accidental releases. In addition, reducing the amount of chemicals on site could prevent suppliers from meeting market demands. It is also unreasonable to think that all hazardous chemicals could be substituted without significant loss of production. Some hazardous materials are produced in intermediary steps of a chemical reaction and are necessary for the production of the final product.

Safety: A Requirement of the Design (cont.)

Inherently safer design is commonly thought of as engineering common sense and is not suitable for legislation. It would be challenging to enforce inherently safer design because there is not an agreed upon methodology to quantify safe practices. Processing plants are often very different from one another, and it would be challenging to develop a program that would encompass all manufactures in a single operation standard. William Allmond, Vice President of Government and Public Relations, Society of Chemical Manufactures Affiliates, supports this argument stating, "Inherent safety is a superficially simply but truthfully very complex concept, and one that is inherently unsuited to regulation" (Glenn Hess, 2014).

Moving forward government officials should focus on strengthening current safety legislation, rather than generating a new program to enforce inherently safer design. This could include stricter security measures in the CFATS program to ensure toxic release does not occur by intentional terrorism. Also, the Frank R. Lautenberg Chemical Safety for the 21st Century Act, signed by President Obama in 2016, could be updated to include more stringent regulation of hazardous materials in a chemical processing plant. Ideas could be adopted from the European Union's REACH program, which is highly focused on substitution of hazardous chemical with safer alternatives. Overall, inherently safer design practice is too broad and complex to be effective as enforced legislation.

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Chemical Regulation: What is the best approach for the U.S.? - Ojas Pradhan

The chemical processing industry in the United States is a broad category of manufacturing companies that handle and produce a wide variety of products (Hogue, U.S. chemical regulation shifts, 2016). As such, it is often difficult to institute universal regulatory measures that cover the range of possibilities that the industry can encounter. Thus, it is essential the U.S. implement a nuanced yet clear approach to chemical regulation that can ensure the public's safety and the company's success. Current legislation, in the U.S. and abroad, provides varying degrees of measures of regulating chemicals. To provide better protections for consumers and more robust support for companies, the U.S. must expand on existing policies, such as the TSCA, by implementing regulations that model the Food and Drug Administration's drug approval process.

In the U.S., chemical regulation is governed by the Toxic Substances Control Act (TSCA). This legislation was first enacted in 1976 to provide the EPA with legal authority to regulate health and environmental hazards from chemical substances (U.S. Environmental Protection Agency, 2017). At the time, growing concerns about chemical manufacturing had spurred public outcry about how products were being manufactured and regulated. Additionally, the chemical manufacturing sector was producing more and more new chemicals every year, with little to no investigation of what the health and environmental effects of these products were (Markell, 2010). Amid this climate, Congress passed the TSCA, which primarily gave the EPA tools to regulate new chemicals before they were manufactured (U.S. Environmental Protection Agency, 2017).

However, the chemical industry still retained a large amount of power as the EPA could only make changes that minimally affected chemical companies (Markell, 2010). As the legislation aged, it became apparent that the EPA needed better tools to protect the public and environment. In 2016, after decades of efforts by the EPA and, notably, Senator Frank R. Lautenberg,

Chemical Regulation - What is the best approach for the U.S.? (cont.)

Congress issued an update to the TSCA (Hogue, Senate sends chemical safety legislation to Obama , 2016). This update gave the EPA the power to evaluate and regulate any commercially produced chemical. In doing so, the agency could play a significantly more active role in protecting the public. One additional piece of this update was the unification of chemical requirements across the country. Prior to the update, regulatory power for existing chemicals was primarily in the hands of states (Hogue, U.S. chemical regulation shifts, 2016). For manufacturers, this created a confusing patchwork of regulations that could mean cumbersome bureaucracy. By banning these localized requirements, the TSCA gave chemical companies a more streamlined approach to chemical regulation. Ultimately, the new legislation consolidated regulatory power under the EPA, providing the agency a more hands-on approach to chemical safety.

This hands-on approach is not without its limitations, though. The greatest strength of the TSCA update – its comprehensive review power – may just be its greatest weakness as well. Given the sheer number of chemicals used in manufacturing and sold on the market, it is a daunting task to work through them all and determine if they are dangerous (Hogue, U.S. chemical regulation shifts, 2016). Under the current system, the EPA must prove that a chemical is dangerous before it can regulate it. As a result, a company can continue to use a hazardous chemical if the EPA has not yet regulated it. To combat this pitfall, the U.S. must implement an approach to chemical regulation that places the burden of proof on the manufacturer.

This new approach could be an extension of the old TSCA mandate that new chemicals entering the market must be evaluated. Extending this mandate to existing chemicals could cut down on the burden placed on the EPA. Under this hypothetical regulation, a company would have to prove that they were handling all their chemicals with safe practices. Certainly, the measure would be beneficial to the public since any chemical in the market would have some sort of evaluative process applied to it. The EPA could mirror their process after the FDA approval process for drugs. To allow a drug to go to market, the FDA mandates a series of clinical and patient tests that become more and more rigorous. Though the FDA uses a much more comprehensive and lengthy approach than what would be required for commercial chemicals, the stage-oriented approval process could be adapted to suit the EPA's needs (U.S. Food and Drug Administration, 2018). For example, the stages could be worker safety, public safety and environmental safety. Similar to how a drug is not allowed to move onto the next phase of testing, a chemical process could be deemed unsafe if it does not meet the requirements of a previous stage. The extent of each stage could be determined by the EPA, but the burden of proving that a chemical meets these requirements would be on the companies.

Though this increased burden may put pressure on chemical companies, it would also more accurately reflect industrial priorities and realities. Since companies would be the ones driving the approval process, the climate of chemical regulation would mirror the industrial climate. This switch would also allow the EPA to shift its focus to chemicals that are more prevalent and allow it to adapt to changing commercial conditions. An additional benefit to companies would arise from the safe practices evaluation. Under this provision, a company could be allowed to use an otherwise dangerous chemical if they proved that it was being handled in a safe manner. Of course, the company would also need to prove that there were little to no downstream and long-term effects from the chemical. In this manner, companies that practiced exceptional chemical safety would not be restricted unnecessarily.

Altogether, chemical regulation is a complex issue that requires a complex solution. Mitigating chemical hazards cannot happen at a high level since it is impossible to plan for every dangerous scenario. Instead, regulation should focus on company-level practices that encourage safety and long-term analysis. In this way, the chemical industry can focus on its commercial priorities and keep the public's best interest at the forefront of all its actions.

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Inherently Safer Design - Jennifer Wayland

People from all over the world have become victims of industrial accidents that resulted in a release of hazardous chemicals into the environment. A chemical release can occur through spillage during transportation due to derailing or overturning, pipelines rupturing, or accidental leaks or releases at industrial plants that use chemicals. These accidental releases may seriously affect the population or ecology of the region experiencing the chemical release. Proper safety measures are extremely important since approximately 85,000 chemicals are manufactured in the United States during a year (Williamson, 2016). The US government also reviews between 2000 and 2500 new chemicals each year. Because of the popularity and growth in the chemical industry, preparations must be made to prevent chemical accidents and attempt to minimize harmful effects. The addition of government regulated inherently safer design can ensure that safety is built into instead of only being added on to chemical plants.

Inherently safer design (ISD) is the design of chemical processes and products with special attention towards the elimination of hazards from the manufacturing process instead of only controlling the hazards. The goals of ISD are to minimize, substitute, moderate, and simplify (Hendershot, 2010). The process is a philosophy and way of thinking, opposed to only a set of methods or tools. The traditional safety approach is the addition of safety features such as alarms, training, sprinklers, and emergency response systems. The potential benefits of using ISD is the possibility of saving money due a decrease in accidents, simpler processes and procedures, and an overall safer plant by focusing on prevention rather than response. If later design rework is required due to not implementing a safe design initially, there will be additional costs and schedule delays. Minimizing hazardous material inventory and substitution are typically the most cost-effective strategies during conceptual design. The goals and intentions of ISD are like that of the green engineering philosophy, which is that the "design, commercialization, and use of chemical processes and products, which are feasible and economical while minimizing the generation of pollution at the source and the risk to human health and the environment (Maher, 2012)." Cooperation between government regulation and industrial companies is essential in preventing future accidents, while considering both this philosophy and inherently safer design, and remaining profitable.

After all, government enforcement of safer practices and technologies may have prevented many of the devastating accidents that have occurred in the past. On August 6, 2012 a fire and explosion took place at the Chevron refinery in Richmond, CA (Moure-Eraso, 2014). A pipe rupture endangered 19 workers and 15,000 residents. Safer design practices would have led to the replacement of corroded pipes with corrosion-resistant piping. On April 17, 2013 an explosion occurred at West Fertilizer Company in West, Texas. A release of ammonium nitrate resulted in 15 deaths and surrounding property damage. The use of safer storage and chemicals would have spared the lives of firefighters and residents. Over 10,000 gallons of chemicals leaked into the Elk River in West Virginia on January 9, 2014 (Toups, 2004). This release resulted in water contamination for over 300,000 nearby residents. Safer design practices would have ensured storage that was resistant to leaks. The implantation of inherently safer design may have prevented these accidents, as well as

The chemical industry is very important to the United States economy; however, steps must be taken to improve its safety. There are several arguments against adopting regulatory inherently safer design. A main concern is that there are already safety regulations in place and accidental releases often occur when those are not being followed. Many companies in the chemical industry are concerned that ISD will lead to additional costs and time during design. However, if safer measures are taken during the design stage, there is an opportunity to save money and time by avoiding reworking design later and decreasing the possibility of disasters.

Modern society is very dependent on the chemical industry. Some common uses are cleaning products, paint, insecticides, and fragrances. Chemicals make a vital contribution in providing trade and employment. However, it is important to ensure the safety of those employees, the surrounding population, and the environment. Allowing the government regulation of inherently safer design could take a step in preventing future hazardous chemical releases. This implantation could result in decreased costs by decreasing accidents, simpler processes and procedures, and safer industrial plants.

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My Co-op Experience in the Pharmaceutical Industry - Paul Flanders

CDMO, PD, cGMP, IQ/OQ/PQ. I knew none of these acronyms when I started working as a Co-op Process Engineer at Tapemark. By the time I left in December, I not only knew what each meant, but I had also done work relating to all of them and used them in daily conversation. Tapemark, located in West St. Paul, MN, is a contract development and manufacturing organization (CDMO) that focuses on transdermal and oral thin films in the pharmaceutical and medical device markets. Because the pharmaceutical industry and regulations are quite complex, I initially had a lot of trouble following along in meetings and customer calls. I eventually got in the habit of bringing a large notepad to every meeting and writing down every word or phrase that I didn't understand. I would then bring that list to an engineer or project manager and have them explain all the acronyms and concepts I didn't understand. While most of these conversations only took about ten minutes, I found this not only improved my pharmaceutical industry knowledge, but also helped me build professional relationships with my coworkers.

As a co-op at a contract manufacturing company, I worked on projects for more than 10 different customers. These projects were in a wide variety of lifecycle stages ranging anywhere from initial feasibility and product development (PD) to commercial products already on the market. Much of the work I did on these projects was related to the manufacturing processes. One aspect of my job was to create and update the setup diagrams (SUD) for many processes to help the operators have a clearer understanding of how the machines should be setup for each project. As a contract manufacturer, multiple customer projects ran on a single machine so when switching over to the next production run, the detail and readability of the SUD was critical in reducing setup times and material waste.

Another way I worked on the manufacturing processes was by aiding the process development phase of projects by qualifying production equipment. The FDA has regulations titled Current Good Manufacturing Practices (cGMP) which aid companies in the proper design, monitoring, and control of pharmaceutical manufacturing. This includes ensuring that any production equipment that will have a direct impact on the final product is qualified. This qualification is done through a series of detailed documents called Installation, Operational, and Process Qualifications (IQ/OQ/PQ). I wrote and executed many of these documents while working at Tapemark and through them, got experience working with vendors and customers to resolve any equipment issues that came up. I also got to have my own equipment acquisition project where I drafted a specification document and then worked with outside vendors to get quotes and present them to management.

These are just a few of the many diverse work experiences I had over my six-month co-op with Tapemark. I learned more than I ever imagined about not only the pharmaceutical industry, but also the business side of engineering and customer/vendor interactions. I highly recommend taking a co-op because the work experience and depth of your projects is invaluable. By the end of my first three months, I didn't feel like just an "intern" anymore. I was treated like a full-time engineer and given significant projects and responsibilities.

India Winterim - Andrew Volkening

I grew up about an hour outside of Chicago, Illinois. As a child we would go to the Chicago Bull's games. I remember my parents warning that if you take the wrong way out of United Center you'd enter a part of town that you did not want to be. Although I always heeded their warning, one night we foolishly, blindly followed the GPS. Me and a few of my buddies ended up in what we thought was real poverty. I am here to say until you visit a country like India you have not seen real poverty.

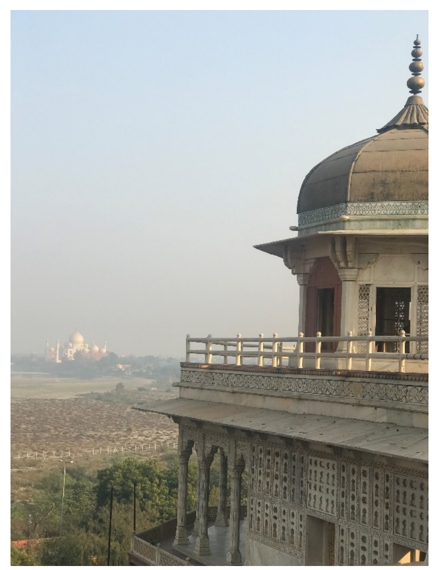
We got into New Delhi past sunset. Upon exiting the airport the thick air filled my lungs. The stray dogs lay asleep in the dirt feet from the road. Our group quietly made our way to the bus that would take us to our compound. Garbage littered the sides of the road. Animals that one would only see penned up in America dug through the trash looking for food. As we pulled up to our housing for the trip we saw a line of shanties. In front of the little tents were a group of thin figures crouched around a little bundle of burning garbage.

Our trip to India was not to aid in poverty relief, although this enlightenment has allowed me a deeper understanding of the human condition in other parts of the world. Growing up when I heard someone say we should help our own in America before sending aid elsewhere I was fully on board. Now I know that those people have not seen the poverty I have experienced. I think it is important to help our own but short sighted to not see the skills we have and can teach other nations and people. This passing off of skills was the reason for our trip.

The objective of our class was to aid in the investigation of the water poverty problem in the rural communities of India. We did this by measuring the depths of water tables, the salinity of water supply, the pathogens present, upkeep of existing water capture vessels, and anything else we could do with the limited resources at our disposal.

In the United States the poverty line is around $11,500 of annual income, this breaks down to approximately $960 per month. Over 87% of people in India make less than 20,000 rupees per month. That equates to approximately 300 USD.

India is a land rich with history, full of life, but in need of aid. This trip as most things in life was not easy, but worth every second.



"Twenty years from now you will be more disappointed by the things you didn't do than by the ones you did do. So through off the bowlines, sail away from the safe harbor. Catch the trade winds in your sails. Explore. Dream. Discover."

-Mark Twain

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Your help is much appreciated!

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