Case study – A two liter pyridine spill in an undergraduate laboratory

A pyridine bottle broke in an undergraduate stockroom, spilling two liters of pyridine onto a student, a bench and the floor. Details are discussed about the safety of the student, the subsequent evacuations of laboratories and finally the whole science building. Remediation of the spill is also discussed. A faculty member with an auto-immune disease was affected by their involvement in the spill cleanup, and the consideration of chemists with auto-immune diseases and their interaction with chemical spills is discussed.

By Barrett Eichler

INTRODUCTION

An undergraduate student was retrieving a small amount of pyridine for a laboratory procedure and the bottle broke upon setting it on the benchtop, spilling two liters of pyridine on the student and the surroundings. Upon cleanup of the spill, one of the faculty members, who has an auto-immune disease, was affected by the pyridine vapors. The objectives of this report are to (1) describe the procedures taken to keep the student safe, (2) describe the procedures to keep the population of the science building safe, (3) describe the remediation of the spill and (4) discuss chemists with auto-immune diseases and their role in spill remediation.

WHAT IS AUGUSTANA UNIVERSITY AND WHAT IS THE AUGUSTANA CHEMISTRY DEPARTMENT?

Augustana University is a selective, private, residential, comprehensive (liberal arts and professional) college of the Evangelical Lutheran Church in American (ELCA) located in Sioux Falls, SD. The student body is mostly undergraduate, although the graduate student population is expanding, which gives a total head count of approximately 1,700 students. The Chemistry Department employs five tenured or tenure-track Ph.D. chemists in each of the five sub-fields of chemistry, one non-tenure-track, full-time Ph.D. chemist and a stockroom manager with a Master's degree in chemistry. Augustana chemistry majors may graduate with one of three bachelor's degrees – an American Chemical Society (ACS) certified degree in Chemistry, an ACS certified degree in Chemistry with a Biochemistry emphasis, or a non-ACS Chemistry degree. On average, there are 10–12 graduates per year. These students proceed on to graduate school (~50%), industry (~25%) or professional schools (~25%).

HOW IS SAFETY HANDLED IN THE AUGUSTANA UNIVERSITY CHEMISTRY DEPARTMENT?

All students working as either teaching or research laboratory assistants must complete a four-hour safety training workshop before their appointment. This workshop is completed on the morning of the first Saturday of the fall semester. This is *required* for all faculty and students (about 40 students per year). It is organized and presented by the faculty and staff in the Department.

This safety workshop involves a mixture of methods of instruction: lecture, commercially available videos and hands-on participation. Expectations of lab assistants are discussed, and the students sign a form saying that they understand of what it means to be an assistant. Then specific safety topics are discussed.

1. *Hazard communication* – use of the chemical inventory, discussion of Augustana's library resources and the chemical hygiene plan, Safety Data Sheets (SDSs).
2. *Safety measures* – use of gloves, laboratory chemical hoods, shields, contact lenses in the lab and general emergency procedures.
3. *Handling hazardous materials* – reagent transport, pictograms, TLV vs. PEL.
4. *Spills and disposal* – disposal collection, prudent practices and more literature resources.

Interspersed with these discussions and videos are "break-out sessions", where students experience hands-on demonstrations with spills (such as a small acid spill on a benchtop), acid–base neutralizations, handling gas tanks and fire extinguishers. A safety quiz is given at the end of the workshop and tours of the Department and science building are given.

Summer assistants (usually around 20 students) must complete a four-hour safety training workshop that is very similar to the fall safety workshop, but also incorporates handling gas-line

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manifolds (Schlenk lines), rotary evaporators and dry ice handling.

Repeated safety workshops, no matter how experienced the lab assistant, are beneficial and by the time the students are juniors, they are very responsible and capable in safety settings. Along with the Ph.D.-qualified instructor, at least two lab assistants work together in lab settings (teaching or research), frequently with at least one upperclassman. All of these factors have created a culture of safety in the Chemistry Department at Augustana and students have responded well in a number of small-scale laboratory incidents over recent years.

Finally, Augustana has a Chemical Safety Committee, which consists of all members of the Chemistry Department and there are discussions about upcoming safety events or incidents that had already happened.

WHAT IS PYRIDINE?

Pyridine, C_5H_5N, is an aromatic, nitrogen-containing hydrocarbon. It smells of rotten fish and is very unpleasant. According to Pohanish,[1] large doses of pyridine, especially through ingestion, may cause liver and kidney damage, however the acute toxicity is low. It is readily absorbed through the skin. The most common acute effect is irritation through inhalation, which causes dizziness, headache, nausea and nervousness. These last effects were the most common encountered in the following incident.

THE INCIDENT

The incident occurred on the Tuesday before the fall Thanksgiving break during a "normal laboratory day." Three separate laboratory sessions were operating: Medicinal Chemistry, General Chemistry and Organic Chemistry. A student in Medicinal Chemistry, who had been a stockroom assistant for over a year, walked through the Organic Chemistry lab to the stockroom to retrieve a small amount of pyridine (~ten milliliters) for his experiment. He set the four liter bottle down at an angle gently on a bench top in the stockroom and the bottle cracked in half diagonally, spilling its contents (~two liters of pyridine) onto the student, the bench top and the stockroom floor. He called for help a number of times, but nobody responded. He then proceeded to walk briskly out of the stockroom, where he caught the attention of the Organic Chemistry instructor and the two senior lab assistants. According to one of the lab assistants, he appeared somewhat disoriented, possibly due to the pyridine vapors. Before anyone could help him, he then proceeded out of the organic lab, down the hallway and down the stairs to a private shower, where he disrobed and then washed the affected areas with water. Two male faculty members were there in less than a minute to assist the student. Most of the pyridine landed on his left thigh and knee, and some red irritation appeared. The student said initially that the affected area felt a little "strange", but after the shower there was no discomfort. The student also said he felt nauseated right away after the spill, but after 24 hours, he felt no ill effects. The student was taken to a local hospital, where he was checked out by a physician and was deemed to be physically unaffected. As a precaution, the doctor gave the student antibiotic, burn and moisturizing creams to administer to the affected area. Subsequent monitoring of the student occurred over Thanksgiving break via both email and phone. The student showed no further acute affects from this exposure.

While the affected student was being assisted, a combination of efforts were split between evacuating the labs and containing the spill.

The stockroom is located between two teaching labs, one of which was an Organic Chemistry lab and the other was a General Chemistry lab. Because the student exited through the Organic lab, the whole class was aware of the situation and the students were quickly evacuated. However, the instructor and students in the adjacent General Chemistry lab were not aware of the situation until a few minutes later, although the students began to smell the pyridine and became nauseated. The instructor left the room to assist in the situation, leaving the lab assistants in charge, and due to complaints of the smell, they moved the students to the other side of the room, not wanting to leave the room without the instructor. The General Chemistry students continued to be nauseated by the smell and were then evacuated from the lab.

Initially, the Stockroom Manager and a Chemistry Department faculty member attempted to contain the spill and sodium bicarbonate was applied to as much of the affected area as possible, but the stench was too overpowering and they had to leave. Sodium bicarbonate was used because it was (1) readily available in quantity and (2) it is a relatively weak amphiprotic substance which can act as either an acid or a base depending on the spilled chemical. People in the other parts of the science building were quickly beginning to smell the pyridine, and within 15 minutes the building was evacuated and classes in the building were canceled for the day.

The faculty had experience in the cleanup of incidental spills (as defined by the OSHA HAZWOPER standard),[2] but this spill was too large. The Sioux Falls Fire Department Hazardous Materials Team was called to investigate and assist in the cleanup of the spill. Due to the fact that they had not encountered a pyridine spill before, they were very cautious and tried to gather as much information as possible. The knowledge of the Chemistry Department faculty was heavily relied upon. Members of the Hazardous Materials Team went into the stockroom with full respirators. The pool of pyridine was 4 feet in diameter, although it was clear that the volatile pyridine had begun evaporating at that point. The laboratory chemical hood in the stockroom was helping to get rid of the vapors. Then the windows in the stockroom were opened. After a few minutes, the Hazardous Materials Team concluded that, using electronic sensors, the concentration of volatile organic compounds (VOC's) was low enough to enter. The Hazardous Materials Team secured the area and the spill was deemed incidental from this point. It was determined that the best plan was to let the ventilation system of the science building take care of the vapors over the long Thanksgiving