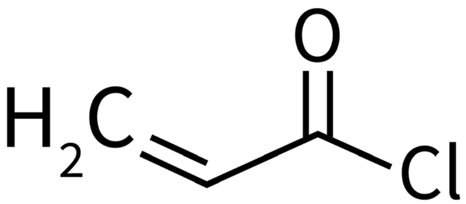
ACRYLOYL CHLORIDE EXPOSURE

Lessons Learned

This Lessons Learned document focuses on an incident in which a researcher received an inhalation exposure to the material acryloyl chloride. It demonstrates the importance of being familiar with the materials you work with, choosing appropriate experimental scales, use of fume hoods, and emergency preparedness training.

What Happened?



A researcher was preparing a reaction that involved the use of acryloyl chloride. The researcher had not worked with this material before, so before beginning they spoke with a postdoc, and decided to reduce the reaction scale tenfold, meaning that they would only be working with 1 gram of acryloyl chloride. While the researcher did not read the safety data sheet (SDS) for the material, they did look carefully at the bottle's label and noted the hazard pictograms indicated there. The researcher was wearing a lab coat, safety glasses, and nitrile gloves.

The researcher decided to measure out the acryloyl chloride by mass rather than by volume. They took the bottle out of the fume hood to a nearby balance and weighed out 1 gram of material into a vial. During this process, they accidentally knocked over the vial containing the acryloyl chloride, spilling the 1 gram amount onto the counter and a small amount on their glove. The material evaporated almost instantly. The researcher immediately removed their glove, and also quickly began to experience severe eye and respiratory irritation: tears began flowing from their eyes, and they began coughing heavily.

Background

- **Acryloyl chloride is a liquid used in chemical synthesis and is the "acid chloride" of the more commonly used chemical acrolein.**
- **Like acrolein, acryloyl chloride is extremely volatile (i.e., evaporates very quickly), is a lachrymator (a substance that irritates the eyes and causes tears to flow), and is extremely acutely toxic by inhalation. Note that lachrymators can cause severe eye irritation even without getting directly into one's eyes.**

No other researchers were in the lab at that moment, but several were in a room directly adjacent. The researcher went and asked for assistance from their labmates, who quickly came to their assistance. The lab safety coordinator assisted the researcher with getting to and using the emergency eyewash. Another labmate called the PI, while another contacted EH&S. EH&S dispatched a specialist to assist with any necessary cleanup and coordinated with local safety partners who were closer to the location of the incident.

Meanwhile, the researcher used the eyewash for roughly 5-7 minutes. The researcher was aware that the general recommendation is to use the eyewash for 15 minutes but felt based on their respiratory symptoms that it was more important to go outside and get fresh air, and they proceeded to do so. They went to the Occupational Health Center, accompanied by the lab safety coordinator. Over the next half hour, their symptoms receded and did not recur, but they still continued with medical follow-up at the Occupational Health Center. The researcher and lab safety coordinator then worked together to submit an SU-17 Incident Report.

Why Did This Happen?

The immediate cause of this incident was working with an open container of a toxic chemical, acryloyl chloride, outside of the fume hood. The researcher chose to weigh out the material as an alternative to performing the extra steps of determining the equivalent liquid volume required and performed this action on the bench instead of in the fume hood.

The root cause was an incomplete risk assessment. Performing formal risk assessments as a standard practice is not yet an embedded part of institutional safety culture. While the researcher did perform some risk assessment (discussed below), they did not fully understand the degree to which acryloyl chloride is toxic. In the aftermath of the incident, they stated that had they known how toxic a chemical it was, they would not have worked with acryloyl chloride outside of a fume hood.

What Went Right?

Acryloyl chloride and similar compounds are capable of causing severe health consequences, up to and including death, even in relatively small quantities. Several factors, including some of the decisions made by the researcher, prevented any of these more serious outcomes.

- One of the most important mitigating factors was the choice by the researcher to scale the reaction down tenfold. While their exposure was relatively brief, a tenfold greater exposure would have resulted in much more serious consequences.
- The laboratory was well-ventilated, with the standard 6 air changes per hour. This meant that although the researcher was exposed to the material in the moments immediately following the spill, the chemical vapors dissipated very quickly given the small quantity.
- The researcher performed some risk assessment. While they did not complete a formal risk assessment or review the SDS, they had evaluated whether the scale of the procedure they were following was appropriate, they spoke with a more experienced lab member, and they noted the hazards listed on the bottle. These steps reduced the overall risk and helped the researcher determine the appropriate response actions.
- The researcher had completed the required safety trainings, including hands-on safety modules offered by EH&S during Fall Training for incoming researchers. During follow-up, the researcher stated that they felt confident regarding what to do partly thanks to these trainings.
- The lab worked well together to react to the incident, both directly assisting the affected researcher and contacting the PI and EH&S.

How to Prevent Incidents Like This

- Perform a risk assessment before performing a new experiment or making significant alterations to an existing procedure. This process should include reviewing the SDSs for all materials involved in the procedure. EH&S recommends using the Laboratory Risk Assessment Tool and is always available for consultation.

- To improve institutional adoption of formal risk assessment as a standard practice, EH&S has ongoing projects including hands-on training on the Laboratory Risk Assessment Tool and outreaches on notable high hazard materials. Additionally, risk assessment is embedded as a core concept in many of our resources and trainings.
- Work with hazardous materials inside of a certified chemical fume hood whenever possible, particularly materials that are toxic by inhalation. If you believe a procedure may require use of hazardous materials outside of a fume hood, contact EH&S for consultation.
  - Weighing out highly toxic materials can be challenging: hazardous materials should not be open outside of the fume hood, but the strong air currents inside a fume hood can cause inaccuracy if the balance is brought inside the fume hood. In these cases, the best practice is to tare a sealable container, measure out a rough quantity of material into this container in the fume hood, seal the container, weigh it, and adjust the amount as needed back in the fume hood.
  - See the general use SOPs for working with highly acutely toxic materials and highly reactive materials for more guidance.
- When working with particularly hazardous materials, consult with your PI and consider writing an SOP for the procedure. SOP templates can be found on the EH&S website, and EH&S is always available to review SOPs, which can be submitted here (please note that such reviews are intended as supplemental to PI review, not a replacement).
- Ensure that lab members know what to do in the event of an incident. Additionally, researchers should know what to do in the event of exposure to the particular materials they are working with.