

Chemical Reaction Explosion



Figure 1: Safety glasses worn by the researcher

Incident:

An explosion occurred recently during a Fischer esterification. The researcher involved was splashed with an acidic solution and immediately rinsed off in a safety shower while near-by lab mates called 911 for emergency assistance. The researcher was working in a fume hood and wearing safety glasses (**Figure 1**) and chemical-resistant gloves, which likely minimized their injuries. The researcher was working socially distanced from lab mates, but still had them available nearby to assist in case of an emergency

Contributing Factors:

The Fischer esterification reaction was run using a new starting material that had partial functionality similar to prior reactants, but the new substrate also introduced a functional group never tested before. The reaction was on a larger scale due to the fact that starting materials are readily available and inexpensive. Also, although this specific reaction had not been performed before, the overall process was well-known to the lab, which reduced the perceived need to begin at a small scale. Our hypothesis is that the product may have been unstable or reacted with excess starting material, which caused an explosive decomposition.

Precautions During New Reactions

The very nature of research is to explore new reactivity. However, to minimize the likelihood of an incident, it is always prudent to test all new reactions on small scale and in a controlled environment before exploring scale up. While testing new reactions, follow these best practices:

- Always run the reaction at small scale (less than gram scale) to observe any incompatibilities or potential issues
- Use safe scaling practices
- Run un-tested reactions during normal hours of operations and never run them alone

General Safe Work Practices

It is best practice to use protective equipment designed to contain the worst case scenario emergency. This means:

- Working in a fume hood with the sash lowered to working height (lower than 18 in)
- Using a blast shield for gram-scale energetic reactions
- Wearing a lab coat, chemical-resistant gloves, and safety glasses during routine chemical work

Working safely while physically distanced: While current public health guidelines call for physical distancing of greater than 6 feet, this incident is another reminder of why working alone is not recommended. Because the policy of the lab is to not work alone, they had socially-distanced lab mates available to help, even though the explosion occurred after normal working hours.

Chemical Reaction Explosion (cont.)

SOPs, Hazard Assessment and Management of Change

Each PI must have written [Standard Operating Procedures \(SOPs\)](#) for high-risk materials and research protocols conducted in their laboratory. Most often laboratory notebooks serve as the individual reaction SOP. However, a risk assessment must be performed when a new high-risk process is implemented and a reassessment must be performed when major changes are implemented (e.g. scale up, novel reactions, etc.). Research staff must be trained on the applicable SOPs and that training must be documented (usually during initial or annual lab-specific training).

Examples of “High-Risk” Processes (NOT COMPREHENSIVE)

- Reactions with energetic material (pyrophoric, explosive, strong oxidizers, strong corrosives, etc.)
- High temperature/pressure or low temperature/pressure reactions (especially if in a sealed vessel)
- Gram-scale procedures or reactions that have been scaled-up
- Novel reactions where the chemistry is not fully understood

Resources for Hazard Assessment

- [ACS “Identifying and Evaluating Hazards in Research Laboratories” Document \(download\)](#)
- [Hazard Assessment in Research Laboratories](#)
- Prudent Practices in the Laboratory, [Chapter 4 Evaluating Hazards and Assessing Risks in the Laboratory](#)

Hazard Class SOP Templates (file download)

- [Flammable Hazard Class](#)
- [Oxidizer Hazard Class](#)
- [Corrosive Hazard Class](#)
- [Reactive Hazard Class: Storage, Transportation, and Disposal](#)
- [Toxic Hazard Class](#)
- [Compressed Gasses Hazard Class](#)

Emergency Procedure Reminders

- If a personal injury has occurred, if there is a fire (even if it is currently out), or a spill in a public area, **call 911!** Stay on scene to inform emergency responders of what happened and where the emergency is.
- Notify University Health and Safety (UHS) and your Department Safety Officer as soon as possible
- Additional reading: [UHS Emergency Procedures Fact sheet](#)

UHS Consultations and Contact Information

Your [Research Safety Partner](#) can help you with hazard assessments and general safe work practices. Contact the [University Health and Safety](#) main office with any additional questions at (612) 626-6002 or uhs@umn.edu.