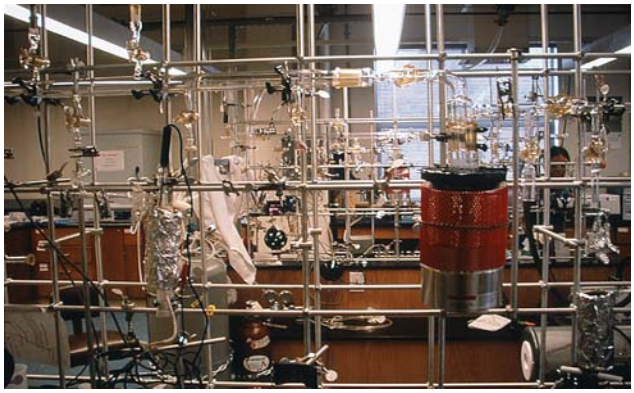
Accident Report: Rupture of Vacuum Flask

Accident Description

A graduate student was attempting to vacuum distill 4-methylanisole (STP boiling point: 174 ^{O}C) at room temperature, and was using liquid nitrogen to condense the anisole into a receiving flask. After some time had elapsed, he observed that no anisole had been transferred to the receiving flask, indicating a possible problem with the setup. He checked the reading on the gauge which indicated that the flask was under a partial vacuum, as expected. He dismantled the setup and removed the receiving flask. Ice had formed around the flask. Seeking to verify what was in the flask, he rinsed it off with cold tap water at a sink. He observed a cloud form in the flask. A few seconds later, the flask shattered, and he was struck in the face, neck, hands and chest by shards of glass. There was no chemical exposure. Fortunately, he was wearing safety eyewear and so did not receive any injuries to his eyes.

Two other people were present in the lab at the time who immediately called 9-911 and requested medical assistance. Fortunately his injuries were not life-threatening. However, he lost a significant amount of blood during the time which elapsed between the accident and the arrival of the paramedics. The student had to have approximately 30 stitches to his face and neck area.



Vacuum rack where flask was manipulated before warming at sink

Conclusions and Recommendations

1. We suspect a crack or leak in the flask caused the explosion. When a flask partly open to the atmosphere is immersed in liquid nitrogen, air is condensed. When the flask is removed from the liquid nitrogen, the pressure can build quickly due to the phase change from liquid to gas causing the glass to shatter. The warming effect of the water may have accelerated the pressure buildup.

2. Researchers using vacuum systems should be diligent about checking their glassware and valving for cracks and other defects before beginning experimental work; particularly those that might compromise the integrity of their vacuum. Verify that systems assumed to be under vacuum are so; particularly when using liquid nitrogen**.** Researchers should always be on the lookout for the possibility of condensed air within their apparatus.

3. While doing experimental work, the wearing of approved safety eyewear (has the designation “Z87” on the frames) is a legal requirement and campus policy. In this lab, wearing of safety eyewear is strictly enforced and in this incident may well have saved the student’s eyesight. Unfortunately, EH&S has observed that in some campus labs, researchers do not always wear their safety glasses and some

PIs/supervisors are lax in enforcing this requirement. Also, each lab should seriously consider if the risk level of their research requires the availability of full face shields, or other specialized personal protective equipment.

4. Use of water to quickly raise the temperature of a vacuum flask at liquid nitrogen temperatures should be avoided when possible. The thermal shock to glassware can be sufficient to crack the glass or pyrex.