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Investigation of an Explosion in a Fume Hood at the Materials Engineering Laboratory

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Description of the occurrence of the explosion:

On 6.10.21, as part of a teaching laboratory, the instructor in charge of the laboratory made a practical overlap with a new instructor entering the position.

As part of the chemical metallographic etching procedure they used a "NITAL" chemical etching solution, which contains: 97% Ethanol + 3% HNO₃.

At the end of the etching process with the NITAL solution, the instructor did not identify the appropriate waste bottle due to the fading of the tag. Therefore, he assumed that the chemical waste bottle suitable for dumping the NITAL solution waste was the bottle labeled "chemical etch waste".

At the end of the experiment and after pouring the substance into the waste bottle, closing the bottle cap, and arranging the lab, the instructors turned to the lab exit. The explosion occurred inside the hood when they were standing at the lab's exit door, and after the explosion the hood's window was seen that it was closed as needed.

Immediately after the explosion, they identified that the instructor had injured her arm as a result of glass penetration. The security was called and they went to the clinic and from there to the hospital for further treatment, which included X-ray and stitching of the wound.

Analysis of the occurrence of the explosion

The chemical waste solution into which the NITAL solution was poured contained a mixture that included a large amount of **concentrated nitric acid** (HNO₃).

It is likely that pouring NITAL into the said solution, **in which the concentration of nitric acid was high**, increased the concentration of nitric acid from 3% in the NITAL itself to a level of ~~over~~ more than 10%. It is known that a solution of ethanol and nitric acid becomes explosive if the concentration of nitric acid reaches over 10%! See <https://en.wikipedia.org/wiki/Nital>



Figure no. 1 - The correct waste bottle for NITAL solution was faded and therefore it was difficult to be identified, therefore, the waste was accidentally **put into the wrong bottle**

Conclusions

1. Putting waste into the wrong waste bottle that contained a large amount of nitric acid, created an explosive mixture with ethanol when the nitric acid was more than 10%.
2. The explosion was intensified as the waste bottle has been tightly closed with a cork.
3. The stickers on the waste bottles weren't clear and especially the sticker on the correct waste bottle for NITAL was completely faded!
4. Bottles of chemical waste shouldn't be closed. It is best to leave a funnel in each bottle and not screw a cork. If the bottle had remained open it would not have created a strong explosion but would have released the pressure into the fume hood.
5. Care must be taken that each chemical is disposed in its own designated bottle.
6. Chemical waste should be frequently removed from laboratories.
7. The instructors did not undergo "chemical safety training" tutorial through the "moodle" as required.
8. The hood was about half closed after the explosion while it is mandatory to be lowered to the maximum (about 20 cm). If the hood had been completely lowered it is possible that there might not have been any injured people in the incident.

9. No Personal Protective Equipment (PPE) was used during the work in the laboratory (the work was done without a lab coat and without goggles).

Recommendations

1. All workers and instructors must pass the “chemical safety training” both by the person in charge in of the laboratory and through the training of the TAU safety unit.
2. There must be clear labeling on all bottles and all waste bottles.
3. It is obligatory to be careful not to close the waste bottles in the fume hood, but to leave them with a funnel only.
4. The fume hood should be lowered as down as possible (up to 20 cm) to protect the employees.
5. All persons that enter the lab: students, instructors, administrative staff, and academic staff, must use personal protective equipment, including: gloves, goggles, lab coat, long pants and closed and sealed shoes. Please, do not allow anyone into the laboratory without appropriate clothing of long pants and closed and waterproof shoes.



Figure 2. Photos showing the remains of the bottles that were broken during the event.