

Lessons Learned: Oil Bath Fires

Recently two fires occurred in campus labs. While the fires were unrelated and occurred in different building they had one thing in common – both were the result of faulty oil bath set-ups. Luckily there was no significant property damage in either incident. Let's look at some of the details.

Incident #1

In the first incident a small-scale chemical reaction was set to run overnight. The set-up included a flask containing the solvent and reagents with a reflux condenser attached to condense the liquid. The reaction vessel was heated with a mineral oil bath. Custodians, looking for a source of water on the hallway floor, entered the laboratory. The water cooling line servicing the condenser had become detached at a connector and was freely spraying water into the hood, onto the floor, and out the door. While the custodians were turning off the water a small, brief fire erupted on the heating element of oil bath in the hood. The custodians used an available extinguisher to put out the fire and called the UWPD. No Madison Fire Department response was necessary.

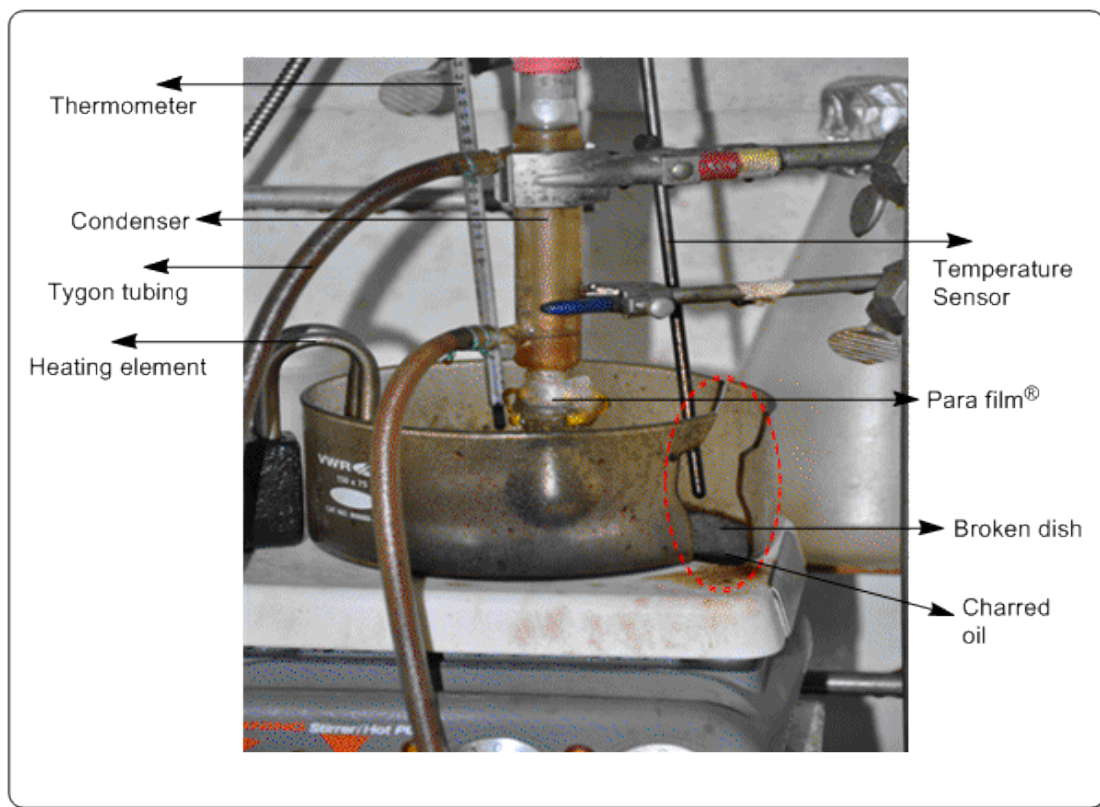


Figure 1. Distillation Apparatus after Fire.

What caused the fire? The most likely scenario is that the water from the disrupted water line had hit the hot glass oil bath container causing it to be heat-shocked. The container then broke, spilling the oil

and exposing the thermocouple and heating element. With the thermocouple no longer reading the proper temperature the controller attempted to maintain the preset temperature (set to around 110°C) by continuing to power the heating element. This overheated the residual oil on the heating element causing it to ignite.

Incident # 2

The second incident resulted in a more serious fire. A researcher was heating an oil bath to 80°C when an apparent failure of a digital controller caused powering of the heating element to continue unabated, eventually heating the oil to its auto-ignition temperature. The resulting fire had flames reaching over 4 feet high. Two fire extinguishers were used by the researcher in an attempt to combat the flames. While each extinguisher momentarily put out the fire, both times the fire restarted – most likely because the oil was still hot enough to re-ignite. In one final attempt the researcher threw water on the fire. This caused a sudden and extremely dangerous surge of the fire. Luckily, the fire was extinguished and as mentioned above the damage was minimal and the researcher escaped any serious harm.

Lessons Learned

What do these incidents teach us? Obviously, heated oil bath set-ups have to be carefully considered. The best approach is to design your experiments so as to avoid fire hazards altogether or at least minimize the chances and potential extent of a fire. If you do have oil baths you should be prepared to deal with emergency situations. Below are some suggestions for all users of oil baths:

- Use a water bath whenever possible. You can normally use water baths up to 80°C without much worry. Other alternatives include heating mantles and sand baths. All of these are non-flammable alternatives to oil baths.
- If you need to use an oil bath make sure you use appropriate oil. Mineral oil is a commonly used for this but in some instances this is not the best choice. The Safety Data Sheet (SDS) for the oil should include the flash point (temperature at which a fire can start with the appropriate ignitions source such as a spark) and auto-ignition temperature (temperature where fires will start without an ignition source). You should not be working near the flash point. A good high-temperature silicone oil can be more expensive, but the cost of the oil is minimal compared to the cost associated with even the smallest fire.
- Always check your oil. All oils will break down over time when they are heated and oils that have been abused are much more likely to start a fire. Change the oil when it gets discolored or if in any way gets contaminated.
- Use a temperature controller. Typical set-ups include a thermocouple connected to a digital controller. Most commercial heating systems have fail-safes designed into the controls. If the thermocouple or other element in the system fails, the power to the heating source will shut down. However, many researchers on campus create their own heating control system from components. Caution should be taken if using this approach. Many off-the-shelf digital control units will have some fail-safe capacities but you need to read the instruction manual to determine how to connect the circuitry properly to avail yourself of these options.
- If you setting up your own system you need redundant controls. A second thermocouple and controller - set at a temperature above first - should be set as a limit controller and should shut the system down when the limit temperature is reached. This limit controller provides additional protection should there be failure in your main temperature controller. Remember

that all controllers and thermocouples will fail – it's only a matter of when and under what conditions.

- Thermocouples that have fallen out of oil baths have resulted in numerous fires in labs around the country. Make sure that the thermocouple is well-secured.
- Never use bare wires to heat oil baths. Use an enclosed heating element, such as a tubular immersion heater (e.g., a calrod).
- Avoid hot spots around the heating elements by stirring the oil. Or alternatively place the thermocouple close to the heating element.
- Water and hot oil do not mix. Even if the temperature is not at the oil's flashpoint, the addition of water can cause thermal shock to the container – even pyrex glass. Make sure all water connections are secure.
- Likewise organics and hot oil do not mix. Should solvent come in contact with the hot oil a fire can result. Check your set-up before starting. Make sure glassware is properly connected and clamped.
- Work in a fume hood and remove any unnecessary flammables. In the event of a fire or spill releases will be contained and damages limited.
- Be prepared. Have the appropriate fire extinguisher and know where it is located. An ABC type fire extinguisher should be able to put out the fire if used properly. EH&S provides free fire extinguisher training on request throughout the year for groups on campus.
- Lastly, but very importantly, ***never try to fight an oil fire with water!!!*** The results can be disastrous. An oil bath fire is usually fairly contained because the surface area is limited. Water added to the fire turns rapidly to steam and pushes the oil out of the container, increasing the surface area and spreading the fire outside of the container.

You can contact us if you have any questions on your set-up or if you have any other concerns.

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For More Information Contact:

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