University of St Andrews

Flame Drying Glassware

1. Introduction

Synthetic chemistry often involves the use of chemical reagents that react violently with air and moisture. To use these reagents safely, the glassware used to contain and manipulate these reagents must be free of residual moisture to prevent unwanted reactions. Moisture free glassware can be achieved through a process known as flame drying in which glassware is placed under vacuum and heated with a heat gun or an open flame (e.g. a Bunsen burner / microburner). Whilst this procedure is commonplace, it involves several hazards that need to be managed. Key hazards and best practices for flame drying of glassware are outlined in the sections below.

2. Consideration of Alternatives

Wherever possible, the use of open flames should be avoided. For many reactions, oven-dried glassware will be sufficient and eliminates the risk associated with an open flame. If additional heating under vacuum is deemed necessary, it may be possible to heat the glassware sufficiently with a heat gun (especially on a lower-temperature setting). Whilst this may offer a safer approach, it is important to recognise that the heating element of a heat gun can also act as an ignition source.

3. Overview of Hazards and Actions to Reduce Risk

If the flame drying of glassware cannot be avoided, it is important that the hazards are identified and actions are taken to reduce the risk of an incident. The key hazards are highlighted below:

3.1 Ignition of flammable solvents, solvent vapours or laboratory consumables.

Flame drying operations require the use of an open flame or a heating element (e.g. from a heat gun) that could act as an ignition source. It is therefore important to ensure the immediate work environment is clear of flammable material. This includes:

- Solvent Winchesters
- Waste solvent containers
- Squeeze bottles containing organic solvents
- Flammable vapours / gases
- Cooling baths containing organic solvents
- Cotton wool
- Paper towels

It is also important to note that, once a piece of glassware has been flame dried, it may be sufficiently hot to cause solvent to ignite. Glassware should be allowed to cool before flammable solvents / reagents are introduced or it is lowered into a cooling bath containing solvent.

3.2 Implosion hazards

Cracked or damaged glassware may implode if placed under vacuum, resulting in glass shards that could cause severe cuts and penetration injuries. If excessive heating is applied to a localised area, the glass may weaken and increase the risk of implosion.

3.3 Burns

If an open flame or stream of hot air from a heat gun is directed at the users' hands, this could result in burn injuries. It is recommended that nitrile gloves are NOT worn when using an open flame. It is also important to note that, once a piece of glassware has been flame dried, it may be sufficiently hot to cause serious burns if in direct contact with the skin. Glassware should be allowed to cool before it is handled further.

4. Training / Supervision

Flame drying glassware is commonly covered in undergraduate teaching courses, however, if you are performing this operation for the first time or need a reminder of how to perform flame-drying operations, please speak to senior lab members (postdocs or supervisors) who can guide you through the process.

5. Illustrative Step-by-Step Approach to Flame Drying

1. Remove all flammable materials from the work area.
2. Select pre-dried glassware
3. Ensure glassware is free of solvent and inspect for cracks / signs of damage. If the glassware is cracked or damaged it should not be used and should be discarded in a glass bin.
4. Clamp the glassware within a fume cupboard equipped with "Fire Trace" suppression
5. Connect the glassware to a Schlenk line and apply vacuum
6. Using a heat gun, microburner or Bunsen burner, heat the flask, ensuring the flame or stream of hot air is directed away from your person and hands. During this operation, an open flame must not be left unattended.
7. Move the flame / hot air stream around the glassware to heat surfaces evenly. You should notice water vapour evaporating from the surface. Avoid excessive heating of a single spot that could result in the glass weakening.
8. Once the surface of the glassware has been heated, the glassware should be allowed to cool. The glassware should only be handled or introduced to a cooling bath once it has reached an acceptable temperature.