The Chemical Safety Mechanism
University of Wisconsin-Madison
Office of Chemical Safety

Heat Gun Use in Research Labs: Prudent Practices

Laboratory heat guns are a common commodity in research labs and are frequently used to dry glassware or to heat the frozen parts of a glassware assembly. It can also be used in heat distillation and to develop Thin-Layer Chromatography (TLC) plates. Heat guns provide a convenient and, if used carefully, safe source of heat. Special attention must be taken to avoid injury and fires.

Fig.1: A Typical Heat Gun

Heat Guns **(Fig. 1)** are constructed with a motor-driven fan that pulls air in and across an electrically heated heating element that typically glows red-hot. It is commonly understood that heat guns, by definition, get hot and that they will significantly raise the temperature of materials that the heat gun is directed towards. But what is not usually considered is that since air is drawn into the heat gun the presence of any solvent vapors in the area where heat guns are used poses a serious ignition hazard that may lead to fire and/or explosion. Contrary to an open flame that cautions the operator to be careful, a heat gun creates a false impression of safety because the danger zone is unseen but very active. The air emerging from a heat gun is very hot and invisible so the front end should be treated with all the respect due to a blow torch.

Common Usage of Heat Guns in Laboratories

Drying glassware: Generally glassware in the laboratory is dried using a laboratory oven at elevated temperature after cleaning and an acetone rinse. A heat gun may be used to dry small glassware for immediate use. To do this, first blow any leftover solvent (acetone, methanol or alcohol) off of the glassware using cold air. This will help prevent flash fires due to residual solvent left on the glassware. The glassware can then be easily dried using a heat gun. During the drying process, hold the glassware using a tong and heat the glass slowly until all of the moisture is gone. The hot glassware can be cooled inside a calcium chloride desiccator to avoid the re-adsorption of moisture on the glass surface.

Larger size glassware's such as condenser, dropping funnels and three neck flasks **(Fig. 2)** are difficult to accommodate inside a laboratory desiccators for drying purpose. So generally they are dried using heating and vacuum instantaneously. A heat gun and vacuum are appropriate for such assembly. The reaction may be assembled in a fume hood where a vacuum and nitrogen line is easily accessible. The reaction assembly may be heated slowly using a heat gun while evacuating the assembly continuously. Heating should not be focused in one direction or area, but equally around the glassware. Do not hold the glass with your bare hands. Use a suitable tong or O-ring clamp for holding the glassware. Do not apply heat to Tygon® tubes or Keck Clips during the drying process. This can cause damage/malfunction. Keck clips lose their holding capacity if they are heated under high temperature.

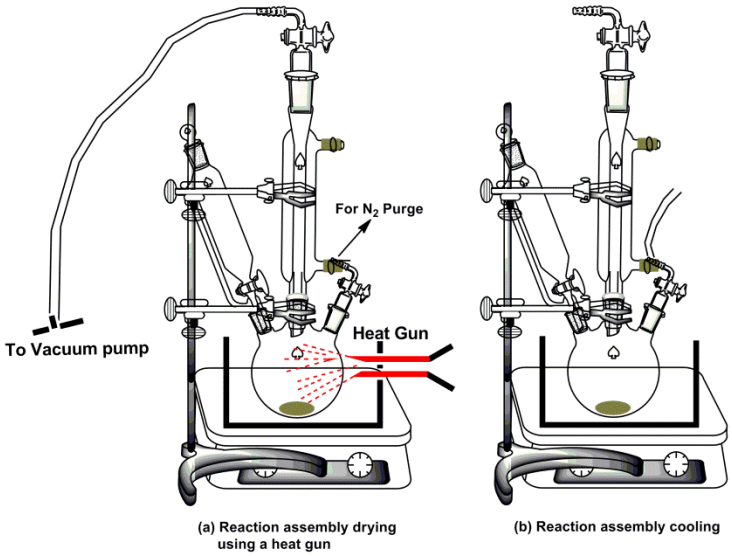

Fig. 2: Large scale reaction assembly drying using a heat gun under vacuum

Developing TLC Plates: Quick removal of solvents from TLC plates and developing glass TLC plates is easily accomplished at low heat **(Fig. 3)**. For solvent removal from TLC plates, the residual solvent must be evaporated in a properly working fume hood before applying heat from a heat gun. Developing TLC plates containing chlorinated or toxic solvents, or developing a large number of plates at one time should be done in a fume hood to prevent accumulation of vapors. The fume hood should be clear of flammable materials. Never try to remove excess amounts of solvent using a heat gun. Use forceps to hold your glassware while using a heat gun otherwise you will risk direct exposure of the heat to your hand.

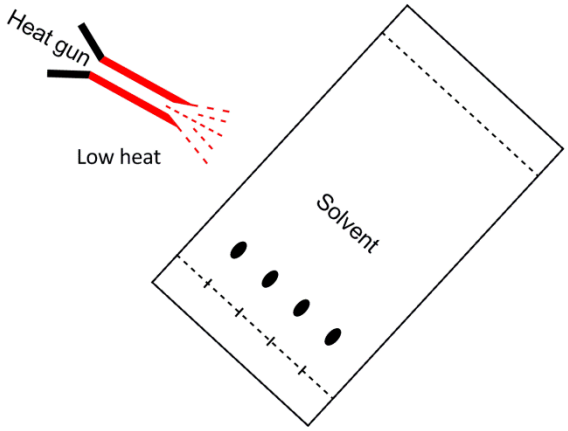

Fig. 3: TLC plate drying using a heat gun

Laboratories Accidents

Accidents have occurred at UW-Madison and other institutions due to improper use of heat guns. The two most notable accidents involved heat guns used in the presence of flammable solvents resulting in fires, property and product loss. These incidents highlight the hazards inherent in the use of heat guns and provide valuable safety lessons.

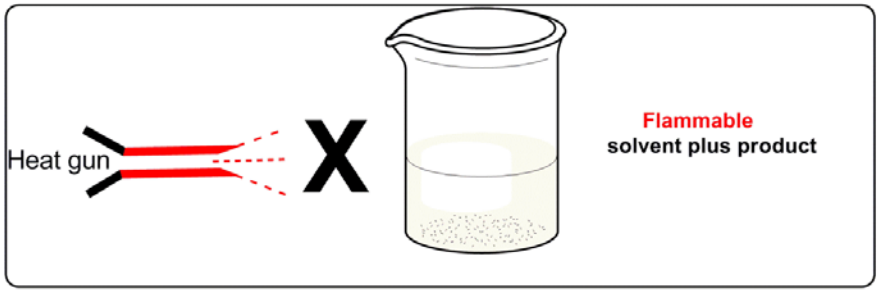

Fig. 4

Incident 1: A laboratory worker was using a heat gun to crystallize product in ethyl acetate in an Erlenmeyer flask. Due to uneven heating and the poor quality of the flask, the flask broke and a splash of ethyl acetate came in contact with the elements of the heat gun, igniting the solvent and causing the worker to toss the flask away from him. The sleeve of the worker's shirt caught fire.

Incident 2: A laboratory worker was using a heat gun to accelerate evaporation of flammable solvent and to develop thin-layer chromatography slides. Several stacks of paper towels, dispensing bottles of flammable solvent, and 100 open vials of flammable solvent were in the fume hood where this process was carried out. The heat from the heat gun ignited the paper and vials of solvent, quickly spreading to the dispensing bottles which added more fuel to the fire. Fortunately, the worker did not sustain any injuries; however, the damage caused to the fume hood and surrounding area was valued at over $32,000.00. The researcher's reaction product was lost as well. The area of the lab involved in the incident was out of commission for several weeks.

Incident 3: A laboratory worker was using a heat gun to heat approximately 0.5 liters of heptane in a Pyrex beaker. He was holding the beaker in his hand over an open bench. A splash of heptane came in contact with the heating elements of the gun causing a spark. The flame spread to the beaker igniting the heptane inside and causing him to toss the beaker away from him. The sleeve of the worker's shirt caught fire. The flaming beaker landed on another work surface, spreading the fire to his computer. The worker immediately used a safety shower to put out the fire on his clothing, and then used a dry chemical fire extinguisher to put out the other fire. The worker received burns to his hand and the computer containing his thesis was destroyed by the powder from the extinguisher.

Heat Gun Safety Tips and Procedures

It's preferred to have a heat gun with variable settings for both temperature and air flow. The type of work and the workspace will determine the heat and air speed settings best suited for the safety of the operator. Below are some of the key tips and procedures for operating a heat gun safely.

- The effective temperature can be reduced by holding the heat gun further away from the surface.
- Do not use a heat gun near combustible or flammable materials/atmospheres.
- Never direct the air flow towards one's body. Heat guns can produce up to 1100^{o}F of flameless heat at the nozzle which can ignite many types if materials use in clothing and can cause severe burns.
- Never touch the hot metal nozzle with clothing or skin.

- Wear appropriate personal protective equipment (PPE) when using a heat gun. A flame retardant lab coat and safety glasses should be considered the minimal requirement (see our previous articles on lab coats and eye protection).
- Recognize the location of fire extinguishers in your lab and how to use them properly. The campus typically provides ABC and CO_2 extinguishers.
- If clothing is on fire, smother the flame by rolling on the ground or use a safety shower to extinguish the fire.
- Always maintain a minimum of 1 cm of clearance between the outlet nozzle and the work surface while using a heat gun.
- Place a hot gun on a level surface with the support stand firmly in place when the tool is not hand held and always switch the tool off before putting it down on any surface.
- Never leave a heat gun unattended during operation or cool-down and allow the heat gun to cool before storing it.
- **Never block the inlet grill** or obstruct the air flow of the unit while in operation. If the air flow is reduced the heat gun will overheat and potentially catch fire.
- Avoid using an extension cord to power a heat gun. Due to the high current draw, extension cords may overheat and pose a risk of a fire or electric shock.

References and Resources:

1. Operators use and care manual, *Steinel HL1800 E*.
2. http://www.nap.edu/catalog.php?record_id=4911.
3. Laboratory Safety for Chemistry Students by Hill and Finster, Wiley, **2010**.
4. Lessons learned at UW-Madison.
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6. http://www.udel.edu/ehs/research/chemical/heat-gun.html.
7. Personal experience Tilak Chandra, Ph.D. Chemical Safety Specialist.

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