Flammable Liquid Safety

Safety Tips for Using Flammable Liquids in School Laboratories

FLINN SCIENTIFIC SAFETY FAX!

Introduction

The use of flammable liquids is an important component of most chemical laboratories. Understanding the properties and hazards of these materials is an important first step in terms of the safe purchase, storage, use, and disposal of flammable liquids.

Safety Precautions

All flammable liquids found in school environments are also organic compounds. Their principal hazard is flammability. Many are also slightly toxic by inhalation and are body tissue irritants. Mild headaches or dizziness may be a symptom of overexposure to an organic vapor. Good ventilation is highly recommended whenever volatile organic compounds are used. Specific hazards for common organic solvents are presented in this review. Always wear chemical splash goggles, chemical-resistant gloves, and chemical-resistant apron whenever using flammable liquids. Consult current Material Safety Data Sheets for specific safety, handling, and disposal information.

Fires and Flammability

Fires need three components to start and to continue—fuel, oxygen, and heat. These components are commonly referred to as the fire triangle and are depicted in Figure 1.

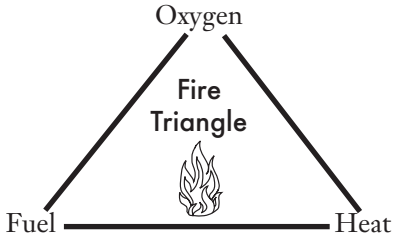

Figure 1.

Removing or disrupting one of the points of the triangle will prevent or extinguish a fire. Should a fire occur in your laboratory, a major concern is to reduce the amount of fuel available to support the fire. For most fires, it is not the flammable liquid or solid that is burning, but rather the vapors (fuel) from the material that is mixing with air and burning. Removing the liquid, however, will quickly reduce the amount of vapor. Smothering the fire will reduce the amount of oxygen available and extinguish the fire.

OSHA classifies the flammability of materials based on how readily a material will begin to burn. Table 1 shows the different classes of flammable and combustible liquids and common examples found in science laboratories. The *flash point* is the minimum temperature at which a liquid forms a vapor above its surface in sufficient concentration that it may be ignited with a spark or flame.

Table 1. Definition of Classes of Flammable and Combustible Liquids

Class	Boiling Points*	Flash Points*	Example
Flammable IA	< 37.8 (100)	< 22.8 (73)	Ethyl Ether, Acetaldehyde, and Petroleum Ether
Flammable IB	≥ 37.8 (100)	< 2 2.8 (73)	Methyl, Ethyl, and Isopropyl Alcohols
Flammable IC	-	between 22.8 and 37.8 (100)	Butyl Alcohol
Combustible II	-	between 37.8 and 60 (140)	Acetone and Acetic Acid
Combustible IIIA	-	between 60 and 93.3 (200)	Cyclohexanol
Combustible IIIB	-	> 93.3 (200)	Ethylene Glycol

*All temperatures are in °C and (°F)

Publication No. 10460
061616

The major difference between a flammable and combustible liquid is the flash point. Flammable liquids are classified as having flash points below 100 °F, which means a spark can ignite them at or near room temperature. Combustible liquids are still dangerous but require more than a spark to ignite them at room temperature. Holding a flame above a combustible liquid will quickly heat it up above its flash point and may start a fire.

The Material Safety Data Sheet (MSDS) contains important information about the flammability of a substance. In addition to the flammability class and the flash point, the MSDS will also list the lower and upper flammable limits, the autoignition temperature, and the NFPA code. The lower and upper flammable limits are the minimum and maximum concentrations, by volume percent in air, in which a fire can be started or maintained. The autoignition temperature is the temperature at which the material will initiate a self-sustained fire even without an ignition source. The NFPA code was developed by the National Fire Protection Association to rate chemicals under fire conditions in four categories: health, flammability, reactivity, and unusual reactivity. Within each category, a numerical rating system has been established in five numerical ratings (0–4). Number 4 is a severe hazard and number 0 is no special hazard.

Purchase

- Before purchasing any organic liquids, ask the following questions:
  - Do I understand the hazards of this material?
  - How often is this chemical used in school setting?
  - What is the educational value of this chemical?
  - Have I used this chemical before?
  - Is my lab equipped for the safe use and storage of this chemical?
  - If these questions cannot be answered positively, please reconsider purchasing the chemical.
- Organic compounds are not easy to dispose of and frequently require costly disposal methods. Purchase only what is required for 1–2 years usage.
- Purchase smaller-sized bottles of flammable liquids whenever possible to keep them fresh and to make storage and handling easier. It is easier to handle a 100- or 500-mL bottle than a 1- or 4-L jug of liquid. Smaller bottles of liquids also contain less liquid that is likely to spill during an accident and thus add less fuel to a potential fire.
- Always purchase flammable liquids in plastic bottles or in PVC-coated glass bottles. PVC-coated bottles will not shatter and spill material when dropped.

Storage

- Store all flammable liquids, solids, and gases in a dedicated flammables cabinet. The best flammables cabinets are built using high-density plywood. Metal is a heat conductor while wood is an insulator. Applying intense heat to a metal flammables cabinet may cause the door to warp and release flammable liquids and vapors into the fire. A wooden flammables cabinet insulates the chemicals inside the cabinet and will withstand a fire better than a metal cabinet. Wooden flammable cabinets have been reviewed and approved by the major standard-setting organizations such as OSHA and NFPA, and by most major city fire departments.
- Flammables storage cabinets should be located in a locked chemical storeroom to prevent theft. The cabinet should also be secured with a lock.
- Within the flammables cabinet, all the materials should be stored using the Flinn Scientific Chemical Storage Pattern.
- A chemical storeroom that contains flammable materials should be equipped with an ABC fire extinguisher, fire blanket, and smoke detector.
- The chemical storeroom should be equipped with an exhaust system. Flinn Scientific recommends a fan that will provide four air changes per hour. The fan should be placed near the ceiling of the storeroom. Since organic vapors are heavier than air, the exhaust system must draw vapors from the floor. Use a galvanized sheet metal duct to draw air from the floor to the exhaust fan near the ceiling.
- If a flammables cabinet in not available, store the flammable liquids in a Flinn Saf-Stor™ can. This will provide good

secondary containment and protection during fires.

- Never store flammable or combustible materials near strong oxidizing agents. As these materials react with one another, heat is evolved and a fire can occur. Use the Flinn Scientific Chemical Storage Pattern to prevent storage accidents.
- Never store flammable liquids in a household refrigerator or freezer. Vapors can build up inside the refrigerator and a spark from the compressor, thermostat, lightbulb, or electrical switch can ignite the vapors. Explosion-proof refrigerators can be purchased but cost 3–4 times more than household refrigerators.
- Diethyl ether may form explosive peroxides over the course of 1–2 years. Buy and store only small quantities of this material.
- Some alcohols form peroxides upon standing. These peroxides can be explosive if they are allowed to accumulate or are concentrated. Do not distill these materials. Consult the *Flinn Scientific Catalog/Reference Manual* or MSDS to determine storage recommendations for specific alcohols.

Transporting

- Secondary containment is critical in preventing major spills or accidents when transporting flammable liquids. Make sure all flammable and combustible liquids are in unbreakable plastic bottles or PVC-coated glass bottles or transport them in unbreakable bottle carriers.
- Always carry large flammable liquid bottles with one hand underneath the bottle and the other hand around the neck of the bottle. This keeps the bottle closer to your body and decreases the risk of hitting a sharp object like a desk corner.
- If a cart is used to transport hazardous chemicals, place compatible chemicals inside an unbreakable secondary containment vessel, such as a plastic tote or bucket. The cart should be equipped with guardrails to prevent plastic totes or bottles from sliding off the cart.
- If hazardous chemicals are moved from one floor to another, use an elevator if possible. Only the teacher transporting the chemicals should be on the elevator. Although elevator accidents are rare, should a dangerous material be released in an elevator while passengers are trapped inside, the results could be catastrophic.

Using and Dispensing Flammable Liquids

- If volatile organic solvents are going to be used, the lab must be well-ventilated or have a working purge fan to ventilate the lab. The laboratory should also be equipped with one or two ABC, dry chemical fire extinguishers and fire blankets in addition to the other normal safety equipment (safety eyewash, safety shower, etc.).
- Always review the MSDS before using any hazardous material in the laboratory.
- Flammable liquids should not be mixed with strong oxidizing agents. As the organic material is oxidized, heat is evolved and may ignite the material resulting in a fire.
- Extreme care must be taken when using flammable liquids around any heat source, flames, or electrical equipment. Laboratory equipment (stirrers, meters, etc.) are designed to be sparkproof, but limiting vapors is a good safety precaution.
- Organic vapors are heavier than air and will quickly travel along a lab bench or floor to an ignition source. Never use flammable liquids around an ignition source. Try to minimize the amount of volatile liquids used and be aware that organic vapors can travel great distances.
- Flammable liquids are very volatile. Dispense them in an operating fume hood.
- Use lab mats and/or plastic trays when dispensing organic solvents to contain spills and drips.
- Students should dispense flammable liquids from smaller bottles to limit spills and fumes. Do not allow students to dipense flammable liquids from a 4-L jug. The larger quantity increases the possibility of contamination and increases the amount of fuel in case of a fire.
- During lab, dispense the flammable liquid from a central dispensing location and have students bring a graduated cylinder or test tube to the dispensing area. This will help to minimize spills and accidents as well as limit the amount of flammable liquid being transported back to the lab bench.

- Instruct students to remove only the amount of flammable liquid needed for the experiment from the reagent bottle. Never add chemicals back to reagent bottles.
- Have spill cleanup materials readily available whenever flammable liquids are used. If a spill occurs, immediately restrict unprotected personnel from the area. Remove all ignition sources and ventilate the area. If the spill is too large to contain, the vapors are overpowering, or ignition sources cannot be completely removed, immediately evacuate the school and call the fire department. If the spill is small, contain the spill with sand or an absorbent material. Depending on the spill material and the amount, allow the spilled material to evaporate off the sand or absorbent material in a fume hood or deposit it in sealed bag or container.
- Absorbent spill pillows are great absorbents for most organic spills. The pillows quickly absorb 10–20 times their weight and disposal is easy.

Personal Protection Equipment and Safety Aids

- Consult the MSDS for the specific personal protection equipment required and other safety precautions for the flammable material being used.
- Neoprene rubber gloves are recommended for use when handling organic solvents. Plastic or vinyl gloves will provide some protection against the occasional splash, small spill, and splatter that may occur when using or dispensing solvents.
- Operating eyewashes must be available in any classroom or laboratory where chemicals are used. Approved eyewashes must treat both eyes and provide a stream of clean, potable water for at least 15 minutes.
- Chemical splash goggles must be worn anytime flammable liquids are used. Safety glasses without complete splash protection are not adequate protection.
- During demos, it is very important that students wear chemical splash goggles anytime flammable liquids are used. The possibility of an explosion or fire always exists and both students and teachers must be protected. If safety goggles are not available, use a heavy duty safety shield to protect your students.

First Aid

- Always seek professional medical attention upon exposure to any hazardous chemical, especially volatile organic solvents. For most organic solvents, the major hazards are flammability and inhalation. If there is a spill or accident, immediately remove any flames, heat, or electrical equipment from the area and begin to ventilate the area.
- If an organic liquid is splashed in the eyes, use an eyewash to irrigate the eyes with fresh, potable water for at least 15 minutes. Make sure the eyelids are held open to properly irrigate them. Ask the victim to look up, down, and sideways to better reach all parts of the eye. After using eyewash, always seek professional medical help immediately.
- If a flammable liquid is splashed onto bare skin, rinse the area with water for at least 15 minutes. Many organic solvents will "dry out" the skin and cause minor dermatitis. If the liquid causes burns or other skin irritations, seek medical help immediately.
- If a large amount of flammable liquid is splashed onto clothing, consider removing the clothing immediately and placing the clothing in a fume hood or outdoors. If flammable liquid splashes onto your skin and clothing, remove clothing and then begin rinsing the affected areas with water (safety shower is ideal).
- If an organic liquid is ingested, please consult the MSDS and immediately call a poison control center or local hospital emergency room. Follow their directions and seek medical attention as soon as possible. For most organic solvents, the goal is to trap the chemical in the stomach and prevent further injury caused by vomiting. Activated charcoal is sometimes given to help trap the chemical. Do not give the victim anything to drink or induce vomiting unless instructed by a medical professional.

Disposal

- Consult a current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes. For small amounts of most volatile organic liquids, Flinn Suggested Disposal Method #18a, evaporation in an operating fume hood, can be used. For larger amounts, a professional chemical waste disposal firm will

have to be used.

- Waste crocks or "slop" buckets are used in many schools for liquid laboratory wastes. Organic wastes should be kept separate from aqueous wastes to prevent any accidental reactions. For organic waste containers, it is best to separate halogenerated organic solvents (e.g. methylene chloride) from other organic solvents (e.g., ethyl alcohol) for disposal reasons. Sometimes, volatile organic solvents can be evaporated in a fume hood from the organic waste container. Be sure to label all waste containers with their approximate contents. Dispose of all waste solutions as soon as possible.

References

Flinn Scientific Catalog/Reference Manual

Lefevre, M. J. *First Aid Manual for Chemical Accidents*, 2nd Ed. Van Nostrand Reinhold: New York, 1989.

CRC Handbook of Laboratory Safety, 4th ed.; Furr, A. K., Ed.: CRC: Boca Raton, 1995.

Fire Protection Guide to Hazardous Materials, 12th ed.: NFPA: Quincy, MA, 1997.

Materials for *Flammable Liquid Safety* are available from Flinn Scientific, Inc.

Catalog No.	Description
SE7021	Flinn 18-gallon Floor Flammable Cabinet
SE8021	Flinn Bench Top Flammables Cabinet
SE9021	Flinn Wall Mount Flammable Cabinet
SE3006	Flinn Fire Blanket with Case
SE3007	Flinn Fire Blanket
SE1034	Fire Extinguisher, ABC Dry Chemical, 5-lb
SE3001	Fire Extinguisher, ABC Dry Chemical, 10-lb
AP3218	Gloves, Neoprene
SE104	Flinn E-Z Pour Absorbent, 128-oz
SE101	Super Sorb® Absorbent, 20 lbs
SE265	Laboratory Spill Mat
SE150	Absorbent Spill Pillows, 250-mL
SE155	Absorbent Spill Pillows, 1-L
AP1690	Flinn DILUTIT™ Laboratory Exhaust Fan
AP1688	Flinn PURGIT™ Exhaust System

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.