

Specific Hazards That May Lead to Fires or Explosions

The combination of certain compounds or classes of compounds can result in a violent chemical reaction leading to an explosion or fire. Other compounds pose explosion or fire hazards when exposed to heat, shock, or other conditions. Listed below are some of the specific compounds and combinations of compounds that may pose explosion or fire hazards, which may be encountered in laboratories. This list is not intended to be complete, but may help labs create specific SOP's for the work they perform.

1. **Acetylenic compounds** are explosive in mixtures of 2.5-8.0% with air. At pressures of 2 or more atmospheres, acetylene subjected to an electrical discharge or high temperature can decompose explosively. Dry acetylides can detonate on receiving a slight shock. Many heavy metal acetylides are sensitive explosives.
2. **Aluminum chloride** should be considered a potentially dangerous material. If moisture is present, there may be sufficient decomposition (generating HCL) to build up considerable pressure. If a bottle is to be opened after long standing, it should be completely enclosed in a heavy towel.
3. **Ammonia** reacts with iodine forming nitrogen triiodide, which is explosive, and with hypochlorites to give chlorine. Mixtures of ammonia and organic halides sometimes react violently when heated under pressure.
4. **Dry benzoyl peroxide** is easily ignited and sensitive to shock and may decompose spontaneously at temperatures above 50° C. It is reported to be desensitized by addition of 20 % water.
5. **Carbon disulfide** is both very toxic and very flammable; mixed with air, its vapors can be ignited by a steam bath or pipe, a hot plate, or a glowing light bulb.
6. **Chlorine** may react violently with hydrogen or with hydrocarbons when exposed to sunlight.
7. **Diazomethane** and related compounds should be treated with extreme caution. They are very toxic (potent carcinogens), and the pure gases and liquids explode readily. Solutions in ether are safer from this standpoint.
8. **Dimethyl sulfoxide** decomposes violently on contact with a wide variety of active halogen compounds. Explosions from contact with active metal hydrides have been reported.
9. **Diethyl, diisopropyl, and other ethers** (particularly the branched-chain type) sometimes explode during heating or refluxing because of the presence of peroxides. Ferrous salts or sodium bisulfite can be used to decompose these peroxides, and passage over basic active alumina will remove most of the peroxidic material. In general, however, old samples of ethers should be carefully and properly disposed of.
10. **Ethylene oxide** has been known to explode when heated in a closed vessel. Experiments using ethylene oxide under pressure should be carried out behind suitable barricades.
11. Halogenated compounds such as **chloroform, carbon tetrachloride, and other halogenated solvents** should not be dried with sodium, potassium, or other active metals; violent explosions are usually the result of such attempts.

12. **Hydrogen peroxide stronger than 3%** can be dangerous; in contact with the skin, it may cause severe burns. Thirty percent hydrogen peroxide may decompose violently if contaminated with iron, copper, chromium, or other metals or their salts.
13. **Liquid-nitrogen** cooled traps open to the atmosphere rapidly condense liquid air. Then, when the coolant is removed, an explosive pressure buildup occurs, usually with enough force to shatter glass equipment. Hence, only sealed or evacuated equipment should be used.
14. **Lithium aluminum hydride** should not be used to dry methyl ethers of tetrahydrofuran; fires from this are very common. The products of its reaction with carbon dioxide have been reported to be explosive. Carbon dioxide or bicarbonate extinguishers should not be used against lithium aluminum hydride fires, which should be smothered with sand or some other inert substance.
15. **Oxygen** tanks: Serious explosions have resulted from contact between oil and high-pressure oxygen. Oil should not be used on connections to an oxygen cylinder.
16. **Ozone** is a highly reactive and toxic gas. It is formed by the action of ultraviolet light on oxygen (air) and, therefore, certain ultraviolet source may require venting to the exhaust hood. Liquid and solid ozone are explosive substances.
17. **Palladium or platinum on carbon, platinum oxide, Raney nickel, and other catalysts** should be filtered from catalytic hydrogenation reaction mixtures carefully. The recovered catalyst is usually saturated with hydrogen and highly reactive and, thus, will inflame spontaneously on exposure to air. Particularly in large-scale reactions, the filter cake should not be allowed to become dry. The funnel containing the still-moist catalyst filter cake should be put into a water bath immediately after completion of the filtration. Another hazard in working with such catalysts is the danger of explosion if additional catalyst is added to a flask in which hydrogen is present.
18. **Parr bombs** used for hydrogenations have been known to explode. They should be handled with care behind shields, and the operator should wear goggles.
19. **Perchlorates**: The use of perchlorates should be avoided whenever possible. Perchlorates should not be used as drying agents if there is a possibility of contact with organic compounds, or in proximity to a dehydrating acid strong enough to concentrate the perchloric acid to more than 70% strength (e.g., in a drying train that has a bubble counter containing sulfuric acid). Seventy percent perchloric acid can be boiled safely at approximately 200°C, but contact of the boiling undiluted acid or the hot vapor with organic matter, or even easily oxidized inorganic matter (such as compounds of trivalent antimony), will lead to serious explosions. Oxidizable substances must never be allowed to contact perchloric acid. Beaker tongs, rather than rubber gloves, should be used when handling fuming perchloric acid. Perchloric acid evaporations should be done in a hood with adequate airflow and a built-in water spray for the ductwork behind the baffle. Frequent (weekly) washing out of the hood and ventilator ducts with water is necessary to avoid spontaneous combustion or explosion if this acid is in common use.
20. **Permanganates** are explosive when treated with sulfuric acid. When both compounds are used in an absorption train, an empty trap should be placed between them.
21. **Peroxides (inorganic)**: When mixed with combustible materials, barium, sodium, and potassium peroxides form explosives that ignite easily.

22. **Phosphorus (red and white)** forms explosive mixtures with oxidizing agents. White P should be stored under water because it is spontaneously flammable in air. The reaction of P with aqueous hydroxides gives phosphine, which may ignite spontaneously in air or explode.

23. **Phosphorus trichloride** reacts with water to form phosphorous acid, which decomposes on heating to form phosphine, which may ignite spontaneously or explode. Care should be taken in opening containers of phosphorous trichloride, and samples that have been exposed to moisture should not be heated without adequate shielding to protect the operator.

24. **Potassium** is in general more reactive than sodium; it ignites quickly on exposure to humid air and, therefore, should be handled under the surface of a hydrocarbon solvent such as mineral oil or toluene. Oxidized coatings should be carefully scraped away before cutting the metal (explosions can otherwise occur).

25. **Residues from vacuum distillations** have been known to explode when the still was vented to the air before the residue was cool. Such explosions can be avoided by venting the still pot with nitrogen, by cooling it before venting, or by restoring the pressure slowly.

26. **Sodium** should be stored in a closed container under kerosene, toluene, or mineral oil.

27. Scraps of **Na of K** should be destroyed by reaction with n-butyl alcohol. Contact with water should be avoided because Na reacts with water to form hydrogen with evolution of sufficient heat to cause ignition. Carbon dioxide, bicarbonate, and carbon tetrachloride fire extinguishers should not be used on alkali metal fires.