

JoVE: Science Education
Chemical Storage: Categories, Hazards and Compatibilities
--Manuscript Draft--

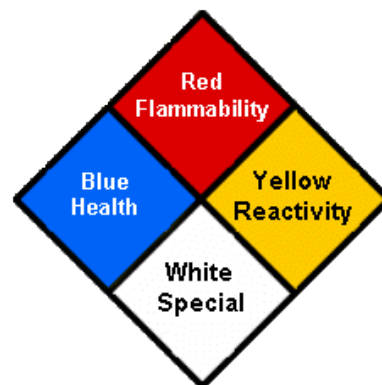
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Science Education Title: Chemical Storage: Categories, Hazards and Compatibilities

Overview: While the use of various chemicals in experimental research is essential, it is also important to safely store and maintain them as a part of the Environmental, Health and Safety (EHS) program. Chemical properties and their reactivity vary broadly and if they are not managed and stored properly they can have harmful or even destructive consequences such as toxic fume production, fire or explosion, which may result in human fatality, property damage or environmental hazards. Proper chemical storage must meet OSHA (Occupational Safety and Health Association) standards and this can prevent most chemical reactivity hazards.

Principles: Chemical storage begins with proper chemical labeling, which identifies the chemical and indicates what chemical hazards are associated to anyone who handles, uses, stores or transports. The National Fire Protection Association (NFPA) diamond symbol rates the degree of health (blue), flammability (red), reactivity (yellow), and special hazards (white) of chemicals. Hazards are rated from zero for no hazard to 4 for severe risk (See Figure 1). Chemicals must then be segregated according to their chemical family or hazard classification and stored appropriately so that any incompatibility is avoided.



Procedure:

1. NFPA 704 Labeling for Hazardous Material

- 1.1. Collect information on hazards from applicable sections of the safety data sheet (SDS) for the chemical. Some SDSs may even provide the NFPA diamond symbol with hazard rating numbers filled in already.
- 1.2. If the SDS does not provide a NFPA diamond label for the chemical, the information may be obtained under the following sections of the SDS:
 - Health hazard information under Section 11
 - Flammability information under Section 9
 - Instability information under Section 10
 - Special information under Section 9, 10, 11Check other sections of the SDS for additional information.
- 1.3. Compare the SDS criteria with the current edition copy of NFPA 704 criteria shown in:
 - Table 5.2 Degrees of Health Hazards

- Table 6.2 Degrees of Flammability Hazards
- Table 7.2 Degrees of Instability Hazards
- Table 8.2 Degrees of Special Hazards

1.4. Once the numbers for the degree of hazard associated with the criteria are determined, place in the correct quadrant of NFPA 704 placard.

2. Segregate Incompatible Chemicals

2.1. Chemicals should always be segregated and stored according to their incompatible chemical and physical characteristics. Basic hazard groups include:

2.1.1. Acids

2.1.2. Bases

2.1.3. Flammables

2.1.4. Oxidizers

2.1.5. Toxics

2.1.6. Peroxide forming chemicals

2.1.7. Pyrophoric forming substances

2.1.8. Water reactive chemicals

2.1.9. Explosives

2.2. Below are some common hazard groups to segregate:

2.2.1. No acids with bases

2.2.2. No bases with acids

2.2.3. No acids or bases with flammables

2.2.4. No oxidizers near compressed flammable gases

2.3. Incompatible chemicals must not be stored in close proximity to each other. In an emergency situation of a fire, earthquake or a spill, incompatible chemicals could mix and react to cause toxic fume production or an explosion.

3. Chemical Storage Method

- 3.1. Chemicals should be stored according to their incompatible chemical and physical characteristics. Alphabetical storage may be used within a compatible chemical group but never as a chemical storage plan for an entire inventory.
- 3.2. Chemicals must be stored in accordance to the manufacturer's directions or SDS instructions.
- 3.3. Liquid chemicals should not be stored over shoulder height to ensure easy access and handling and be stored in chemically resistant secondary containers in case there is a leak or spill.
- 3.4. Chemicals containers should be stored with closed and properly fitted caps.
- 3.5. Acids and bases should be stored separately and stored in acid cabinets or on protected shelves which are not metal in order to avoid corrosion
- 3.6. Flammable and combustible chemicals must be stored in approved flammable storage cabinets and kept away from any ignition source, oxidizers or corrosives. Flammable storage cabinets should be properly vented into the building's dedicated vent system. Laboratory-grade flammable-safe refrigerators should be used when flammable chemicals require refrigeration. Do not store food or beverages in the laboratory refrigerator.
- 3.7. Toxic chemicals should be stored in a ventilated, cool and dry area.
- 3.8. Peroxide forming chemicals must be dated upon delivery and opening and be disposed before the expected date of initial peroxide formation and be stored in a dark, cool and dry area.
- 3.9. Air and water must be removed rigorously from containers of pyrophoric forming substances and should be stored away from flammables in a cool and dry area.
- 3.10. Explosives should be stored away from all other chemicals in a secure location and away from shock or friction.

Summary: Research laboratories often contain many chemicals that may pose distinct hazards to our health and well-being. Proper storage and maintenance of these chemicals can help prevent accidents and provide a safe working environment. While the list of chemicals may vary by laboratory and experiments, this document provides a basic guideline to storing and maintaining chemicals. Specific hazard assessment may reveal more specialized and additional storage requirements.

References:

1. Quick Card National Fire Protection Association at http://www.nfpa.org/Assets/files/AboutTheCodes/704/NFPA704_HC2012_QCard.pdf

- Occupational Health and Safety (OSHA) Brief on Hazard Communication Standard: Labels and Pictograms, 29 CFR 1910.1200 (HCS) at <https://www.osha.gov/Publications/OSHA3636.pdf>
- Occupational Health and Safety (OSHA) Regulations (Standards - 29 CFR) 1926.152 - Flammable liquids at [https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10673#1926.152\(a\)](https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10673#1926.152(a))
- NFPA 30: Flammable and Combustible Liquids Code at <http://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards?mode=code&code=30>
- Occupational Health and Safety (OSHA) National Research Council Recommendations Concerning Chemical Hygiene in Laboratories Standard-1910.1450 App A at https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10107

RGN	Reactivity Group	Incompatible With RGN:
1	Acids, Mineral, Non-Oxidizing	4-15,17-26,28,30-34,101-107
2	Acids, Mineral, Oxidizing	3-34,101-103,105-107
3	Acids, Organic	2,4,5,7,8,10-12,15,18,21,22,24,265,33,34,102-105,107
4	Alcohols and Glycols	1-3,8,18,21,25,30,34,104,105,107
5	Aldehydes	1-3,7,8,10,12,21,25,27,28,30,33,34,104,105,107
6	Amides	1,2,21,24,104,105,107
7	Amines, Aliphatic and Aromatic	1-3,5,12,17,18,21,24,30,34,104,105,107
8	Azo Compounds, Diazo Compounds and Hydrazines	1-5,9,11-13,17-23,25,30-34,102-107
9	Carbamates	1,2,8,10,21,22,25,30,104,107
10	Caustics	1-3,5,9,13,17-19,21,22,24-27,32,34,102,103,107
11	Cyanides	1-3,5,9,13,17-19,21,22,24-27,32,34,102,103,107
12	Dithiocarbamates	1-3,8,17-19,21,25,30,34,103,104,107
13	Esters	1,2,8,10,21,25,102,104,105,107
14	Ethers	1,2,104,107
15	Fluorides, Inorganic	1-3,107
16	Hydrocarbons, Aromatic	2,104,107
17	Halogenated Organics	1,2,7,8,10,11,20-23,25,30,104,105,107
18	Isocyanates	1-4,7,8,10-12,20-22,25,30,31,33,104-107
19	Ketones	1,2,8,10,11,20,21,25,30,104,105,107
20	Mercaptans and Other Organic Sulfides	1,2,8,17-19,21,22,25,30,34,104,105,107

21	Metals, Alkali and Alkaline Earth Elemental	1-13,17-20,25-27,30-32,34,101-104,106,107
22	Metals, Other Elemental and Alloys as Powders, Vapors or Sponges	1-3,8-10,17,18,20,28,30,34,102-104,106,107
23	Metals, Other Elemental and Alloys as Sheets, Rods, Drops, Moldings	1,2,8,17,102-104,107
24	Metal and Metal Compounds, Toxic	1-3,6,7,10,26,30,34,102,103,106,107
25	Nitrides	1-5,8-13,17-21,26-27,30,31,34,101-104,106,107
26	Nitrites	1-3,10,21,24,25,30,104,105,107
27	Nitro Compounds, Organic	2,5,10,21,25,104,105,107
28	Hydrocarbons, Aliphatic, Unsaturated	1,2,5,22,30,104,107
29	Hydrocarbons, Aliphatic, Saturated	2,104,107
30	Peroxides and Hydroperoxides, Organic	1,2,4,5,7-9,11,12,17-22,24-26,28,31-34,101-105,107
31	Phenols and Cresols	1,2,8,18,21,25,30,34,102-105,107
32	Organophosphates, Phosphothioates, Phosphodithioates	1,2,8,10,21,30,34,104,105,107
33	Sulfides, Inorganic	1-3,5,8,18,30,34,102-104,106,107
34	Epoxides	1-5,7,8,10-12,20-22,24,25,30-33,102,104,105,107
101	Combustible and Flammable Materials, Misc.	1,2,21,25,30,102,104,105,107
102	Explosives	1-3,8,10,13,21-25,30,31,33,34,101,105-105,107
103	Polymerizable Compounds	1-3,8,10-12,21-25,30,31,33,102,104,105,107
104	Oxidizing Agents, Strong	1,3-9,11-14,16-23,25-34,101-103,105,107
105	Reducing Agents, Strong	1-8,12,13,17-20,26,27,30,31,32,34,101-104,106,107
106	Water and Mixtures Containing Water	1,2,8,18,21,22,24,25,33,105,107
107	Water Reactive Substances	ALL!

Table 1. Chemical compatibility chart. Obtained from Penn State Environmental Health and Safety website at http://legacy.ehs.psu.edu/hazmat/chemical_compatibility.cfm