

## Appendix 7: Dangerous combinations of chemicals (not limited to)

Dangerous chemical combinations are subdivided into:

- Combinations of chemicals that produce toxic reaction products.
- Combinations of chemicals that cause violent reactions.
- Chemicals that react with water.

### Combinations of chemicals that produce toxic reaction products.

Combination	Reaction product	Toxic
Arsenical substances	Reducing agents	arsine
Cyanides	acids	hydrocyanic acid
Hypochlorites (hypochlorite)	acids	chlorine, hypochlorous acid
Nitrates	sulphuric acid	nitrogen dioxide
Phosphorus	strong bases or reducing agents	phosphine
Nitric acid	copper, heavy metals	nitrogen dioxide
Selenides	reducing agents	hydrogen selenide
Sulphides	acids	hydrogen sulphide

### Combinations of chemicals that cause violent reactions.

**acetaldehyde**, ignites spontaneously at 140°C and higher (in the presence of air); disintegrates on heating above 400°C, forming flammable gases: carbon monoxide, methane and hydrogen

**acetone**, *explosive with*: concentrated mixtures of nitric acid and sulphuric acid, nitric acid, sodium hypobromites and other strong oxidants, chloroform

**acetylene** see: ethyne

**activated carbon**, *explosive with*: calcium hypochlorite, calcium oxichloride (chlorinated lime), all oxidizing agents, ammonium nitrate, chlorine monoxide

**alkali metals**, *explosive with*: carbon tetrachloride and other halogenated hydrocarbons, carbon dioxide, acids, chlorine, hydrogen fluoride, maleic anhydride, ethyne (acetylene), halogenated silver salts and water

**alkaline solutions**, *explosive with*: zinc (galvanised vessels)

**aluminium powder**, *explosive with*: bromine, chlorine, carbon tetrachloride and many other chlorinated hydrocarbons, iodine, cyan, hydrogen, carbon monoxide, carbon dioxide (in fire extinguishers)

**ammonia**, *explosive with*: mercury (e.g. in manometers), chlorine, calcium hypochlorite, iodine, bromine, hydrogen fluoride, silver compounds

**ammonium nitrate**, *explosive with*: powdery metals, flammable substances, chlorates, nitrates, nitrites, sulphur, finely powdered organic or flammable substances, activated carbon, decomposes on heating

**ammonium nitrite**, explodes with shocks or heating above 70°C

**aniline**, *explosive with*: nitric acid, hydrogen peroxide, ozone, peroxides

**acetic acid**, *explosive with*: chromium acid, nitric acid, some hydroxy compounds, perchloric acid, peroxides, permanganates

**benzene**, *explosive with*: potassium permanganate, acidified with sulphuric acid

**benzoyl peroxide**, explodes with shocks and heating

**flammable liquids**, *explosive with*: ammonium nitrate, chromium acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens, organic peroxides

**bromine**, *explosive with*: ammonia, ethyne, butadiene, butane, methane, propane (and other petroleum gases), hydrogen gas, sodium carbide, turpentine, benzene, phosphorus, flammable substances and finely powdered metals

**calcium carbide**, *explosive with*: water, silver nitrate, copper solutions, sodium peroxide, reacts with water thereby creating ethyne (acetylene)

**chlorine**, *explosive with*: ammonia, ethyne, butadiene, butane, methane, propane (and other petroleum gases), hydrogen gas, sodium carbide, turpentine, benzene and finely powdered metals

**chlorine dioxide**, *explosive with*: ammonia, methane, hydrogen phosphide, hydrogen sulphide, mercury, organic material, sugar, carbon dioxide, carbon monoxide

**chlorates**, *explosive with*: ammonium salts, acids, powdery metals, sulphur, finely powdered organic or flammable substances, cyanides

**chloroform**, *explosive with*: acetone, potassium, sodium

**chromium acid (anhydride)**, *explosive with*: acetic acid, naphthalene, camphor, glycerol, turpentine, alcohol, flammable liquids

**cumene hydroperoxide**, *explosive with*: organic flammable liquids and inorganic acids, metals and metal salts (decomposition)

**hydrocyanic acid**, *explosive with*: alkaline metals, potassium nitrite, nitric acid; explodes when heated above 450°C

**ethanol**, *explosive with*: strong oxidants

**ethyne (acetylene)**, *explosive with*: chlorine, bromine, iodine, fluorine, mercury, silver, copper, copper salts, mercury salts, silver salts

**fluorine**, *explosive with*: all other substances

**phosphorus (white)**, *explosive with*: air, oxygen, hydroxides, ammonium nitrate, potassium permanganate, sulphur, silver nitrate

**glycerol**, *explosive with*: strong oxidants

**charcoal**, can self-ignite under unfavourable conditions

**iodine**, *explosive with*: acetylene, ammonium hydroxide, ammonia, hydrogen, phosphorus (white or yellow)

**potassium**, *explosive with*: bromine, chlorine, iodine, acids, carbon dioxide, water, carbon disulphide, chlorinated hydrocarbons (carbon tetrachloride, chloroform, methyl chloride etc.); ignites in air through slight temperature increase, through contact with water or water vapour; explodes with rubbing, rolling and cutting

**potassium chlorate**, *explosive with*: acids and organic substances, silver sulphide, finely powdered metals, sugar

**potassium perchlorate**, *explosive with*: acids (see also chlorates), finely powdered metals

**potassium permanganate**, *explosive with*: glycerol, ethylene glycol, benzaldehyde, sulphuric acid

**potassium sulphide**, *explosive with*: diazo compounds; self-ignites when freshly prepared in the air; causes an explosion on contact with ionised salts and in water solutions; can also explode through self-decomposition

**carbon (activated)**, see activated carbon

**hydrocarbons**, *explosive with*: fluorine, chlorine, bromine, chromium acid, sodium peroxide

**copper**, *explosive with*: acetylene, hydrogen peroxide, chlorates, bromates, iodates

**mercury**, *explosive with*: acetylene, oxalic acid, ammonia

**LPG (liquefied petroleum gas)**, *explosive with*: air (lower explosion threshold 2%); an LPG/air mixture can be ignited with just a small spark, such as from a switch or from nylon clothing

**manganese acid**, *explosive with*: benzaldehyde, ethylene glycol, glycerol, sulphuric acid

**sodium**, *explosive with*: bromine, chlorine, iodine, acids, carbon dioxide, water, carbon disulphide, chlorinated hydrocarbons (carbon tetrachloride, chloroform, methyl chloride etc.)

**sodium nitrite**, *explosive with*: ammonium nitrate and other ammonium salts, cyanides

**sodium peroxide**, *explosive with*: alcohols, glacial acetic acid, acetic acid anhydride, carbon disulphide, glycerol, organic substances in general; explodes spontaneously when mixed with acetone, organic solvents or powdery metals

**metal nitrates**, *explosive with*: sulphur, carbon, organic substances

**nitrobenzene**, *explosive with*: strong oxidants, many organic and inorganic compounds; explodes on quick heating to 200°C

**solvents (flammable)**, *explosive with*: ammonium nitrate, halogen, nitric acid, chromium acid, hydrogen peroxide, sodium peroxide

**oxalic acid**, *explosive with*: silver, mercury, sodium chlorite, sodium hypochlorite

**perchloric acid**, *explosive with*: ether, acetic acid anhydride, bismuth and its alloys, alcohols, paper, wood, charcoal, chipboard and organic material

**nitric acid (concentrated)**, *explosive with*: acetic acid, formic acid, aniline, nitrobenzene, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases; can cause organic substances to ignite; these substances explode on contact with persulphates and thiosulphates

**silicon**, *explosive with*: strong oxidants

**nitrogenous colourants**, can cause dust explosions

**hydrogen peroxide**, *explosive with*: copper, chromium, iron, most metals and their salts, flammable liquids and solids, aniline, nitromethane, alcohols, acetone; causes some organic substances to ignite, self-explodes when mixed with acetone, organic solvents or powdery metals; explodes on heating or stirring when concentrated

**iron powder**, *explosive with*: potassium perchlorate, potassium bichromate, acids, sulphur; spontaneously ignites in air on contact with sulphur

**iron sulphide**, *explosive with*: organic substances, damp air; in this case it is self-igniting

**silver**, *explosive with*: acetylene, oxalic acid, tartaric acid, fulminic acid, ammonium compounds

**zinc powder**, *explosive with*: hydroxides, acids, ammonium nitrate, halogenated hydrocarbons; self-ignition point 440°C

**oxygen**, *explosive with*: oil, fats, hydrogen, flammable substances

**carbon disulphide**, *explosive with*: nitric acid, oxidants

**hydrogen sulphide**, *explosive with*: smoking nitric acid, oxidants

**sulphuric acid**, *explosive with*: chlorates, perchlorates, permanganates, carbides, fulminates, picrates, metal powders, organic substances

### Chemicals that react with water

The letter in the column behind the substance indicates the type of reaction with water as named on the next page of this appendix.

Substance	Type of reaction
Acetyl chloride	B
Aluminium chloride	D
Aluminum tripropyl	A
Acetic acid anhydride	A
Barium and alloys	C
Boron tribromide	A
Bromine trifluoride	B
Cadmium amide	A
Cadmium nitride	A
Calcium and alloys	C
Calcium carbide	H
Calcium phosphide	E
Calcium oxide	F
Cerium nitride	C, D
Caesium	C
Caesium amide	C
Chlorosulphonic acid	F
Chlorine trifluoride	B

Diborane	B
Dipotassium nitroacetate	A
Fluorine	B
Phosphorus oxychloride	F
Phosphorus pentachloride	B
Phosphorus pentoxide	B
Phosphorus chloride	C
Phosphorus oxide	B
Hybrids of alkali and alkaline-earth metals	B
Iodine pentafluoride	B
Potassium	C
Potassium amide	B
Potassium carbide	A
Potassium carbonyl	A
Potassium oxide	B
Potassium persulphate	F
Lithium	B
Lithium amide	B
Lithium borohydride	B
Lithium silicide	H
Lead amide	A
Magnesium aluminium phosphide	E
Sodium	C
Sodium amide	B
Sodium carbide	A
Sodium carbonyl	A
Sodium phosphide	E
Sodium hydroxide	G
Sodium methylate	G
Sodium nitromethane	A
Sodium oxide	B
Sodium peroxide	B
Rubidium	C
Strontium alloys	C
Thallium amide	A
Thallium nitride	A
Zinc sulphide	E
Zinc powder	C
Sulphur monochloride	B
Concentrated sulphuric acid	G

## List of abbreviations and terminology

### Meaning of the letters A to H

<b>A</b>	The substance explodes
<b>B</b>	The substance reacts violently and may catch fire
<b>C</b>	The substance decomposes with heat generation, releasing hydrogen gas which catches fire
<b>D</b>	The substance decomposes with heat generation, releasing acidic or toxic gases or vapours
<b>E</b>	The substance decomposes with heat generation, releasing toxic hydrogen phosphide (PH <sub>3</sub> ) which spontaneously catches fire in the air
<b>F</b>	The substance decomposes while generating a lot of heat
<b>G</b>	The substance only generates heat without decomposing
<b>H</b>	The substance decomposes, creating a gas other than H <sub>2</sub> or PH <sub>3</sub> which catches fire

### References

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