Hazardous Chemical Reactions in Art

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Many art materials are inherently hazardous, including toxic solvents and many metals, corrosive acids and alkalis, flammable solvents and combustible materials such as wood dust, and so forth. However, artists not only have to be concerned about the hazardous properties of their art materials, but also have to be concerned about hazardous chemical reactions that can occur. These hazardous reactions can occur in two basic ways: first, many art processes result in the production of toxic chemicals or other hazards as by-products of the process; and, second, many art materials are incompatible with other chemicals and can create toxic chemicals if they are accidentally mixed. In addition, some art materials are incompatible with heat, ultraviolet radiation, and other physical processes. These decomposition products and incompatibilities should be listed in the Reactivity section of Material Safety Data Sheets.

Hazardous Art Processes

Many art processes such as acid etching, acid pickling, kiln firing, photographic developing, patina application, etc. involve chemical reactions to produce the desired effect. However, these chemical reactions often produce other chemicals which are hazardous. For example, nitric acid etching on zinc plates involves a chemical reaction in which the zinc metal is converted into soluble zinc ions, thus creating etched lines or areas in the parts of the plate that are not covered with acid-resistant grounds or resists. This same chemical reaction, however, also converts the nitric acid into nitrogen oxide gases, including nitrogen dioxide which can cause chemical pneumonia and emphysema. Flammable hydrogen gas is also produced. Thus there is the need for local exhaust ventilation to remove these unwanted gases.

Many art processes also create physical hazards such as noise, vibration, ultraviolet and infrared radiation. In particular, glassblowing, metal melting, pottery and enameling kiln firing all produce infrared radiation and heat. Arc welding, carbon arcs and neon sculptures produce ultraviolet radiation.

See Table 1 for a list of art processes and their hazardous chemical by-products.

Incompatible Art Materials

Acids, oxidizers, oxygen, heat and ultraviolet radiation are common examples of chemicals and physical agents that are often incompatible with art materials. Acids can react with many chemicals. Often artists take advantage of this to create a desired effect, for example, acid etching as described above. Often however, these reactions are not intended or desired and can create hazards. Acids, for example, can react with ammonia and other alkalis to neutralize them. This neutralization reaction produces large amounts of heat which can result in spattering of boiling acid and alkali. Acids can also react with cyanides and other chemicals to produce poison gases (e.g., hydrogen cyanide).

Oxidizers are chemicals that can react with solvents, charcoal, wood dust, and other finely divided organic materials to cause a fire or explosion. Examples of strong oxidizers are concentrated nitric acid, dichromates and chromates, nitrates, and potassium chlorate.

Oxygen in the air can oxidize linseed oil (e.g. oil paints, intaglio and lithographic inks) and other organic oils and turpentine, releasing heat in the process. If this heat can build up, for example a pile of oil-soaked rags in a corner, spontaneous combustion occurs resulting in a fire.

Heat and ultraviolet (UV) radiation are sources of energy that can react with many chemicals to decompose them. Examples include the production of hydrogen cyanide gas from heating or exposing potassium ferricyanide (Farmer's Reducer) to ultraviolet radiation, and the production of acrolein, a strong respiratory irritant and allergic sensitizer, and other decomposition products from the overheating of wax.

Table 2 lists the incompatibilities of many common art materials.

Storage

It is important to store art materials safely so that they will not react with each other if there is an accident and they mix. Incompatible chemicals should be stored separately to avoid this problem. For example, oxidizers should be stored separately from other chemicals, particularly combustible ones. Acids should be stored in a separate acid cabinet, with concentrated nitric acid stored separately from other acids. In addition, materials such as zinc plates should be stored away from even dilute nitric acid solutions because of the risk of an unwanted chemical reaction occurring in case of spills.

Table 1. Chemical Reaction Hazards of Art Processes

Process	***Materials***	***Hazard***
Acid etching	*Zinc, nitric acid*	*Produces nitrogen dioxide and hydrogen gas.*
Dutch mordant	*Mixing hydrochloric acid and potassium chlorate*	*Produces chlorine gas.*
Acid pickling	*Sulfuric acid, sodium bisulfate*	*Heating produces sulfur dioxide gas.*
Batik	*Wax*	*Overheating and ironing out wax creates acrolein and other decomposition products.*
Cleanup	*Rags, paper towels*	*Oil, turpentine, lithotine or d-limonene soaked rags or paper towels can cause spontaneous combustion.*
Fuel-fired furnaces and kilns	*Gas, wood, etc.*	*Produces carbon monoxide from incomplete combustion.*
Jewelry	*Silver soldering*	*Fluorine-containing fluxes decompose to fluoride and hydrofluoric acid fumes.*
Lost wax casting	*Wax burnout*	*Produces acrolein and other decomposition products.*
Photography	*Fixing bath*	*Decomposition of fixer hypo and sodium bisulfate produces sulfur dioxide gas.*
	Sulfide and sepia toning	*Produces hydrogen sulfide gas.*
	Selenium toning	*Produces sulfur dioxide gas.*
Plastics sculpture	*Polyurethanes*	*Heating, machining produces decomposition including hydrogen cyanide*
	Polyvinyl chloride	*Heating, machining produces decomposition including hydrogen chloride*
	Plexiglas	*Heating, machining produces decomposition including methyl methacrylate*

Pottery	*Bisque firing*	*Decomposition of impurities in clay produces carbon monoxide, sulfur dioxide,etc.*
	Salt firing	*Decomposition of salt to hydrogen chloride resulting in hydrochloric acid.*
	Raku firing	*Smoke and carbon monoxide from reduction firing in sawdust, leaves, etc.*
Stained glass	*Soldering*	*Zinc chloride fluxes decompose to hydrochloric acid. Other fluxes also have hazardous decomposition products.*
Welding	*Arc welding*	*Produces ozone and nitrogen dioxide.*
Wood working	*Particle board, plywood*	*Machining decomposes formaldehyde-based glues to formaldehyde.*

Table 2. Incompatible Art Materials

Material	Uses	Incompatabilities	Hazard
Acetic Acid	*photography* *dyeing*	*see Acids*	
Acids	*etching* *pickling* *cleaning* *dyeing*	*alkalais*	*Neutralization of acid with alkali releases heat which can cause boiling*
Alkalais	*cleaning* *dyeing* *photography*	*acids*	*see above*
Ammonium bichromate	*dye* *mordant* *photo* *printmaking* *lithography*	*see Oxidizers*	
Ammonium hydroxide	*patina* *photography*	*see Alkalis and Bleach, household*	

Ammonium nitrate	*patina*	*heat; see also Oxidizers*	*Flammable*
Ammonium persulfate	*photography*	*see Oxidizers*	*Explosive*
Ammonium sulfide	*patina*	*see Sulfides*	
Ammonium thiocyanate	*photography*	*acids*	*Forms hydrogen cyanide*
Arsenic compounds	*glassblowing* *old pigments*	*acids, alkalis*	*Forms arsine gas*
Benzoyl peroxide	*plastics*	*see Peroxides*	
Bichromates		*see Dichromates and Oxidizers*	
Bisulfites	*photography*	*acids*	*Forms sulfur dioxide*
Bleach, household	*photography* *preservative* *dyeing* *preservative* *photo silkscreen*	*acids* *ammonia*	*Forms chlorine gas* *Forms poison gas*
Chlorinated hydrocarbons	*degreasers* *fabric cleaner*	*heat, acids, UV*	*Forms phosgene gas*
Chromates	*ceramics* *pigments*	*see Oxidizers*	
Chromic acid	*cleaner*	*see Oxidizers*	
Copper Nitrate	*patina*	*see Oxidizers*	
Cyanides	*photography* *electroplating* *cleaning gold*	*acids*	*Forms hydrogen cyanide*
Dichromates	*lithography* *photo printmaking* *dye mordant*	*see Oxidizers*	
Dioxane	*film splicing*	*oxygen in air*	*Forms explosive*
Ethers	*solvent*	*oxygen in air*	*Forms explosive peroxides*

Ethylene dichloride	*solvent*	*see Chorinated hydrocarbons*	
Ferric ferrocyanide	*blueprinting*	*acid, heat, UV*	*Forms hydrogen cyanide*
Ferric nitrate	*patina*	*see Oxidizers*	
Hydrofluoric acid	*glass etching lithography*	*see Acids*	
Hydrogen peroxide, concentrated	*photography patina*	*see Oxidizers*	
Lead chromate	*pigment*	*see Oxidizers*	
Lye	*papermaking*	*see Alkalis*	
Methyl chloroform	*solvent*	*see Chlorinated hydrocarbons*	
Methylene chloride	*paint remover*	*see Chlorinated hydrocarbons*	
Methyl ethyl ketone peroxide	*plastic resin hardener acetone*	*see Peroxides, organic*	*explosive*
Nitrates	*patinas*	*see Oxidizers*	
Nitric acid, conc.	*intaglio*	*see Oxidizers see Acids*	
Oxidizers -		*wood dust, solvents, organic material*	*Flammable, explosive*
Perchloroethylene	*degreaser dry cleaning*	*see Chlorinated hydrocarbons*	
Periodates	*cleaning photo silkscreens*	*see Oxidizers*	
Peroxides, organic	*plastic resin hardener*	*heat*	*Flammable, explosive*
Phosphoric acid	*lithography*	*see Acids*	

Potassium chlorate	*intaglio*	*hydrochloric acid see Oxidizers*	*Produces chlorine gas*
Potassium dichromate or bichromate -		*see Dichromates and Oxidizers*	
Potassium cyanide	*gold cleaning electroplating*	*see Cyanides*	
Potassium ferricyanide	*photography patina*	*acids, heat, UV*	*Forms hydrogen cyanide*
Potassium periodate -		*see Oxidizers*	
Potassium permanganate	*photography*	*see Oxidizers*	
Potassium persulfate	*photography*	*see Oxidizers*	
Potassium sulfide	*patina photography*		*see Sulfides*
Potassium thiocyanate	*photography*	*see Ammonium thiocyanate*	
Selenium compounds	*photography stained glass*	*acids*	*Forms hydrogen selenide gas*
Sepia toners	*photography*	*acids*	*Forms hydrogen sulfide*
Sodium bisulfite	*photography*	*acids*	*Forms sulfur dioxide*
Sodium bisulfate	*pickling*	*acids, heat*	*Forms sulfu dioxide*
Sodium cyanide -		*see Cyanides*	
Sodium dichromate or bichromate -		*see Oxidizers*	

Sodium formaldehyde bisulfite	*dyeing*	*heat, acid*	*Forms formaldehyde*
Sodium hypochlorite	*bleach*	*heat, acid*	*Forms chlorine gas*
Sodium sulfide	*photography* *patina*	*see Sulfides*	
Sulfides -		*acids*	*Forms hydrogen sulfide*
Sodium sulfite	*photography*	*see Sulfites*	
Sulfites	*photography*	*acid*	*Form sulphur dioxide*
Sulfuric acid	*lithography* *dyeing* *electroplating* *Anodizing*	*heat* *see also Acids*	*Forms sulfur dioxide*
1, 1, 1-Trichloroethane	*solvent*	*see Chlorinated hydrocarbons*	
Trichloroethylene	*degreaser*	*see Chlorinated hydrocarbons*	
Turpentine	*solvent*	*oxygen in air*	*Spontaneous combustion with rags*
Zinc chromate	*pigment*	*see Oxidizers*	
Zinc sulfide	*pigment*	*see Sulfides*	

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