Lithography and Relief Printing

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General Chemicals

Inks

Intaglio, lithography and relief inks consist of pigments suspended in either linseed oil or water as a vehicle. There can be additional hazardous binders or preservatives.

Hazards

Linseed oils are not considered hazardous by skin contact or inhalation but the ingestion of large amounts of some treated linseed oils might be hazardous due to the presence of small amounts of toxic heavy metals. Oil vehicles are flammable when heated and rags soaked in linseed oil may ignite by spontaneous combustion.

Precautions

1. Know what materials are used. Obtain the Safety Data Sheet (SDS) on all products used. Use the least toxic inks possible.
2. Do not use an open flame to heat linseed oil, varnishes, or burnt plate oil
3. Place oil-soaked rags in self-closing disposal cans.

Pigments

Pigments are the colorants used in lithography, intaglio and relief printing inks. There are two types of pigments: inorganic pigments and organic pigments.

Hazards

1. Pigment poisoning can occur if pigments are inhaled or ingested. For normal printing with prepared inks, the main hazard is accidental ingestion of pigments due to eating, drinking or any inadvertent hand to mouth contact.
2. Some examples of toxic inorganic pigments are lead chromate and pigments based in cobalt, cadmium, and manganese.
3. The long-term hazards of the modern synthetic organic pigments have not been well studied.

Precautions

1. Obtain SDSs on all pigments.
2. Use the safest pigments possible. Avoid lead pigments.
3. Avoid mixing dry pigments whenever possible. If dry pigments are mixed, wear an appropriate respirator. (Contact UNC Asheville EH&S office for enrollment in the University's respirator protection program.

Solvents

Organic solvents are used in printmaking to dissolve and mix with oils, resins, varnishes, and inks. They are also used to clean plates, rollers and tools.

Hazards

1. Repeated or prolonged skin contact with solvents can cause defatting of the skin and resultant dermatitis. Many solvents can also be harmful through skin absorption.
2. Inhalation of solvent vapors is the major way in which solvents are harmful. High concentrations of most solvents can cause dizziness, nausea, fatigue, and loss of coordination.
3. Many solvent s are toxic if ingested.
4. Most solvents are flammable.

Precautions

1. Obtain the SDSs on all solvent products used. Use the least toxic solvent possible.
2. Use adequate ventilation.
3. Keep minimum amounts of solvents on hand and purchase in smallest practical container size. Large amounts of solvents or solvent-containing materials should be stored in a flammable storage cabinet.
4. Do not allow open flames or other sources of ignition near solvents.
5. Ensure the proper fire extinguisher is present and in working order.
6. Wear appropriate gloves when handling solvents.

Acids

Acids are used in in intaglio and in lithography. Strong acids commonly include nitric acid, hydrochloric acid, and phosphoric acid. Less commonly used acids include carbolic acid, chromic acid, hydrofluoric and sulfuric acids. Ferric chloride is used in intaglio and lithography at UNC Asheville.

Hazards

1. Concentrated acids are corrosive to the skin, eyes, respiratory system and gastrointestinal system. Dilute acids can cause skin irritation on repeated or prolonged contact.
2. Chromic acid is a skin sensitizer, suspect carcinogen, and oxidizer.
3. Phenol is highly toxic by skin absorption and ingestion. It may cause severe kidney damage, central nervous system effects and even death if absorbed in large amounts.

4. Hydrofluoric acid is highly toxic and can cause severe, deep burns, which require medical attention. There is no immediate pain warning from contact with hydrofluoric acid.
5. Concentrated nitric acid is a strong oxidizing agent and can react explosively with other concentrated acids and solvents. Nitric acid gives off various nitrogen oxide gases, including nitrogen dioxide, which is a strong lung irritant and can cause emphysema.

Precautions

1. Obtain the SDS for all acids used in the printing lab.
2. Whenever possible, avoid using concentrated acids.
3. Acid etching requires working in an enclosed hood or other suitable exhaust means.
4. Store concentrated nitric acid away from organic materials. Concentrated nitric acid should always be stored separately, even from other acids.
5. Always add acid to water when diluting concentrated acids, never the reverse.
6. Wear appropriate gloves, goggles and protective apron when handling acids.
7. If acid is spilled on your skin or in case of eye contact, rinse affected area with water for 15 minutes using an eyewash/safety shower and then seek medical attention.

Lithography

Lithography uses either zinc and aluminum metal plates or stones for printing. It involves use of a variety of chemicals to make the image ink-receptive and non-image areas receptive to water and ink-repellent.

Plate and Stone Preparation

A variety of drawing materials with high wax and fatty acid content are used to make the image, including tusche and lithographic crayons. Airbrushing liquid drawing materials or using spray enamel or lacquer is also common. Other materials used in stone or plate processing include etch solution containing acids and gum arabic, counter etch solutions containing acids and sometimes dichromate salts, and fountain solutions containing dichromate salts. Phenol (carbolic acid) has been used for removing grease from stones, and a variety of solvents including lithotine, gasoline, kerosene, and mineral spirits, which are used for diluting drawing materials, washing out images and correction of images. Talc and rosin mixtures are also used. Metal plates are prepared with solvent-based vinyl lacquers.

Hazards

1. Acids used include phosphoric, nitric, acetic, hydrochloric, hydrofluoric and tannic acids. The concentrated acids are corrosive, and even dilute acid solutions can cause skin irritation from prolonged or repeated contact. Hydrofluoric acid and phenol are the most dangerous to use.
2. Lithotine, kerosene, and mineral spirits are skin and eye irritants and inhalation can cause intoxication and respiratory irritation.

3. The solvents contained in vinyl lacquers can include highly toxic isophorone and cyclohexanone. Methyl ethyl ketone (MEK), which is moderately toxic, is often used as a thinner.
4. Dichromate salts may cause skin and nasal ulceration and allergic reactions, and are suspect cancer-causing agents.
5. Rosin dust may cause asthma and allergic dermatitis. There is the hazard of explosion from the buildup of rosin dust, in enclosed rosin boxes, around an ignition source.
6. Talcs may be contaminated with asbestos and silica.
7. Airbrushing drawing materials or using spray enamel paints is more hazardous than drawing with a brush because the inhalation hazard is higher.

Precautions

1. Obtain the SDS for all materials used.
2. See Acids and Solvents sections for the precautions with acids and solvents.
3. Use the least toxic solvents. Gasoline should never be used. Lithotine and mineral spirits are less toxic than the more irritating kerosene.
4. Use asbestos-free talcs such as baby powders.
5. Avoid dichromate containing counter etches and fountain solutions if possible. Do not use hydrofluoric acid or phenol.
6. Appropriate gloves, goggles and a protective apron should be worn when mixing or using concentrated acids.

Printing and Cleanup

For all types of lithographic inks, solvents are used to make image corrections on the press, to remove images, and to clean the press bed and rollers.

Hazards

Some roller cleaners and glaze cleaners can contain chlorinated hydrocarbons such as perchloroethylene and methylene chloride. Most chlorinated solvents (except 1,1,1-trichloroethane) have been shown to cause liver cancer in animals and are therefore suspect human carcinogens. In addition, perchloroethylene can cause liver damage, and methylene chloride heart attacks.

Precautions

1. Know materials used. Obtain the SDS for all solvents. See Solvents section for the precautions to use with solvents.
2. Choose products that do not contain chlorinated solvents whenever possible.
3. For small-scale solvent use in correcting images or cleaning the press bed using lithotine or mineral spirits, dilution ventilation (e.g. window exhaust fan) is sufficient.

Intaglio

Intaglio is a printmaking process in which ink is pressed into depressed areas of the plate and then transferred to paper. These depressed areas can be produced by a variety of techniques, including acid etching, drypoint, engraving and mezzotint.

Etching

Etching involves use of dilute nitric acid, Dutch mordant (hydrochloric acid plus potassium chlorate) or ferric chloride to etch the zinc or copper (respectively) metal plate. Unetched parts of the plate are protected with resists such as stopout varnishes containing ethyl alcohol, grounds containing asphaltum or gilsonite and mineral spirits, rubber cement, and rosin or spray paints for aquatinting. Sometimes, soft grounds contain solvents that are more toxic.

Hazards

1. See Solvents section for the hazards of solvents. 1,1,1- trichloroethane found in some soft grounds is moderately toxic by inhalation under normal conditions but may cause fatalities at very high concentrations.
2. See Acids section for the hazards of acids. In particular, nitric acid etching releases the respiratory irritant nitrogen dioxide, which has poor odor warning properties. During the etching process, flammable hydrogen gas is also produced.
3. Concentrated nitric acid is a strong oxidizing agent and can react with many other chemicals, especially solvents or other organic compounds, to cause a fire.
4. Mixing hydrochloric acid with potassium chlorate to make Dutch mordant produces highly toxic chlorine gas. Potassium chlorate is a key ingredient in many pyrotechnics, and is a potent oxidizing agent. It can react explosively with organic compounds, sulfur compounds, sulfuric acid or even dirt or clothing. On heating, it can violently decompose to oxygen and potassium chloride. Storage and use are very dangerous and require special precautions especially when mixing.
5. Rosin dust (and asphaltum dust which is also sometimes used) is combustible. Sparks or static electricity have caused explosions in enclosed rosin and aquatint boxes. Rosin dust may also cause asthma and dermatitis in some individuals.
6. Inhalation of solvents and pigments can result from use of aerosol spray paints.

Precautions

1. Obtain the SDS for all materials used.
2. See Solvents and Acids sections for specific precautions.
3. Use Dutch mordant with extreme caution. A safer substitute for etching copper plates is ferric chloride (iron perchloride). This forms acidic solutions so should be handled accordingly, but does not have the dangers of handling concentrated acids. Ferric chloride solution might cause minor skin irritation from prolonged contact.

4. Application of grounds or stopouts should be done with local exhaust ventilation, (e.g. slot or enclosed hood).
5. Acid etching should be done with local exhaust ventilation. See section on precautions for Acids for more information. Rosin (or asphaltum) boxes should be explosion-proof. Use spark proof metal cranks, explosion-proof motors, or compressed air. Do not use hair dryers to stir up rosin dust.

Other Techniques

Drypoint, mezzotint and **engraving** use sharp tools to incise lines in metal plates.

Hazards

1. One major hazard associated with these types of processes involves accidents with sharp tools.
2. Long-term use of these tools can cause carpel tunnel syndrome, which can cause numbness and pain in the first three fingers. Severe cases can be incapacitating.

Precautions

1. Keep tools sharp, store them safely and always cut away from yourself.
2. When possible, clamp down plates to avoid slippage.
3. Minimize the chance of carpel tunnel syndrome by choosing tools with wide handles, avoiding tight grips, and do hand flexing exercises during regular rest periods. Set worktable height so wrist-flexing motions are minimal.

Printing and Cleanup

Intaglio inks contain pigments, treated linseed oil and modifiers. Printing involves placing the ink on the inking slab, inking the plate by hand, and then printing. Cleanup of inking slab, press bed, and cleaning the plate is done with a variety of solvents including mineral spirits, alcohol, lithotine, turpentine, etc.

Hazards

1. Preparing your own inks from dry pigments can involve inhalation of toxic pigments. See Pigments section for the hazards of pigments.
2. See Solvents section for the hazards of solvents. Plate cleaning is more hazardous than cleaning inking slabs or press beds because larger amounts of solvents are used.
3. Lithotine, turpentine, or oil-soaked rags can be a spontaneous combustion hazard if improperly stored.

Precautions

1. See Pigments and Solvent sections for the specific precautions for pigments and solvents.
2. NIOSH-approved respirators with organic vapor cartridges can be used if ventilation is not adequate.

Relief and Other Printing Processes

Other printing processes include relief printing, collagraphs, monoprints, and plastic prints.

Relief Printing

Relief printing techniques include woodcuts, linoleum cuts and acrylic plates for plaster relief. These techniques involve the cutting away of plate areas that are not to be printed. Relief inks can be oil-based or water-based.

Hazards

1. Some woods used for woodcuts can cause skin irritation and/or allergies. This is particularly true of tropical hardwoods.
2. Accidents involving sharp tools can result in cuts.
3. Woodcarving and cutting tools can cause carpel tunnel syndrome.
4. Caustic soda (sodium hydroxide) is sometimes used for etching linoleum. It can cause skin burns and severe eye damage if splashed in the eyes.
5. Hazardous solvents are used in stopouts and resists in linoleum etching and for cleaning up after printing with oil-based inks. See Solvents section for more information on the hazards of solvents.

Precautions

1. Obtain the SDS for all materials used.
2. See Acids and Solvents sections for precautions with acids and solvents.
3. Water-based inks are preferable to oil-based inks since solvents are not needed.
4. Wear appropriate gloves, goggles and protective apron when handling caustic soda.
5. If the chemical is spilled on your skin, wash with lots of water. In case of eye contact, rinse the eyes with water for at least l5-20 minutes and contact a physician.
6. Always cut in a direction away from you, with your free hand on the side or behind the hand with the tool.
7. Carpel tunnel syndrome can be minimized or avoided by using tools with wide handles, avoiding tight grips, and rest periods with hand flexing exercises. Linoleum cutting is softer to work, and thus can reduce musculoskeletal injury.

Collagraphs

Collagraphs are prints produced by using a collage of different materials glued onto a rigid support. A wide variety of materials and adhesives can be used in making collagraphs.

Hazards

1. Rubber cement, a common adhesive used with collagraphs, is extremely flammable and most rubber cements and their thinners contain the solvent n-hexane, which can cause damage to the peripheral nervous system (hands, arms, legs, and feet) from chronic inhalation.

2. Epoxy glues can cause skin and eye irritation and allergies.
3. Spraying fixatives on the back of collagraph plates to seal them can involve risk of inhalation of the solvent-containing spray mist.
4. Sanding collagraph plates, which have been treated with acrylic modeling compounds or similar materials, can involve inhalation of irritating dusts.

Precautions

1. Know the hazards of materials used. Obtain the SDSs from the manufacturer.
2. Use the least toxic materials available. In particular, use water-based glues and mediums (e.g. acrylic medium) whenever possible. Some rubber cements are made with the solvent heptane, which is less toxic than n-hexane, primarily because peripheral neuropathy is not associated with its use.
3. Wear gloves when using epoxy glues.
4. Wear a NIOSH-approved toxic dust respirator when sanding collagraph plates.

Plastic Prints

Plastic prints can involve making prints from a wide variety of plastic materials and resins.

Hazards

Plastic prints can involve hazards from inhalation of plastic resin vapors (e.g. epoxy resins) and from inhalation of decomposition fumes from drilling, machining, sawing, etc. of finished plastics.

Precautions

1. Obtain the SDS for all materials used.
2. See Solvent section for the precautions with solvents.
3. Use the least toxic material available.

Monoprints

Monoprints involve standard intaglio, lithographic and other printmaking techniques, but only one print is made. Monoprints have the same hazards involved in plate preparation and printing as the parent techniques.

Photo printmaking

Photo printmaking involves exposing a light-sensitive emulsion or film to ultraviolet light through a transparent support containing an opaque image to transfer the image to a plate. The transparency through which the photo emulsions are developed can include drawings on a transparent support such as Mylar or acetate, or photographic images processed on graphic arts film to yield a positive image. Several photo printmaking methods will be discussed.

Photolithography

Photolithography involves transferring graphic images to stones or metal plates that are coated with a light-sensitive emulsion. One can coat the stone or metal plate, or use pre-sensitized metal plates. Light-sensitive emulsions used on stone consist of a mixture of powdered albumin, ammonium dichromate, water, and ammonia. Commercial emulsions are usually based on diazo compounds. Developing solutions for these mixtures often contain highly toxic solvents. Diazo-sensitizing solutions, developers with highly toxic solvents, plate conditioners containing strong alkali, and other brand name mixtures are used for metal plates.

Hazards

1. Diazo photoemulsions are the least hazardous although they can cause eye irritation.
2. Ammonium dichromate used for stone is a probable human carcinogen, is moderately toxic by skin contact, and may cause allergies, irritation, and external ulcers; it is highly flammable and a strong oxidizer.
3. Ammonia is a skin irritant and highly toxic by inhalation. Ammonia is highly corrosive to the eyes. It has good odor-warning properties.
4. Light exposure sources include photoflood lamps, vacuum Poly- Lite units, and carbon arcs. Carbon arcs produce large amounts of ultraviolet radiation, which can cause skin and eye damage and possible skin cancer. Carbon arcs also produce hazardous metal fumes, and ozone and nitrogen dioxide (which can cause emphysema), and toxic carbon monoxide.
5. Screen cleaning solutions include strong caustic solutions, enzyme detergents that can cause asthma, and chlorine bleach. These are skin and respiratory irritants.
6. Many solvents used in developing solutions are highly toxic by both inhalation and skin absorption.

Precautions

1. Obtain a SDS for all materials used.
2. See Solvents section for more precautions with solvents.
3. Avoid ammonium dichromate and use pre-sensitized plates if possible. If you cannot substitute, wear gloves and goggles. Store it away from heat, solvents and other organic materials.
4. Use ammonia solutions or solvent-containing photolithographic solutions inside a laboratory hood, or in front of a slot exhaust hood. Wear gloves, goggles, and if ventilation is inadequate, a respirator.
5. Do not use carbon arcs unless they are equipped with local exhaust ventilation exhausted to the outside. Quartz mercury or metal halide lamps are safer.
6. Wear gloves, goggles and plastic apron or laboratory coat when mixing hazardous chemicals.

Photoetching

Photoetching is usually done using the KPR products. Photoresist dyes often contain a variety of highly toxic solvents, including ethylene glycol monomethyl ether acetate (2-ethoxyethyl acetate, cellosolve acetate), ethylene glycol monoethyl ether, and xylene, and benzaldehyde. The developers contain xylene

and ethylene glycol monomethyl ether acetate (2-methoxyethyl acetate or methyl cellosolve acetate). Developers used for safer pre-sensitized plates also contain solvents. Exposure of the plate is done with ultraviolet sources such as carbon arcs, mercury lamps, or metal halide lamps.

Hazards

1. See the Solvents section for the hazards of various solvents. In particular, methyl and ethyl ether acetates of ethylene glycol are highly toxic by skin absorption and inhalation and can cause anemia, kidney damage, testicular atrophy and sterility in men, and miscarriages and birth defects in pregnant women.
2. Xylene is moderately toxic by skin absorption, and highly toxic by inhalation and ingestion. It is a strong narcotic.
3. The Photolithography section discusses carbon arc hazards.

Precautions

1. See Solvents section for precautions with solvents.
2. Pregnant or nursing women, children, and men trying to conceive should not work with these materials.
3. Use photofloods or other light sources instead of carbon arcs. Precautions with carbon arcs is discussed in the Photolithography section.
4. Use pre-sensitized plates if possible.
5. Use photoresist solutions with local exhaust ventilation, or wear an organic vapor respirator. Wear butyl rubber gloves when handling KPR solutions.