CHEMICAL TOUR
by THURSTON JAMES, THEATRE DESIGN AND TECHNOLOGY, SPRING 1995

The theatre craftsperson has always been eager to accept new technology into his or her shop as soon as it develops. Most of the chemicals we use in the theatre were not formulated for our benefit, they were designed for industrial purposes, but we have been quick to open our arms and give them a warm welcome. although we have discovered problems with some of the materials, we have not rescinded the welcome.

Some of these chemicals are perfectly safe to use. Most are safe when used with precautions. A few are dangerously poisonous. This article will attempt to arrange the chemicals according to their use, place their names into an understandable catalog, point out some of the dangers, and steer you away from the most toxic.

NAMES:

If you have no background in chemistry, you may find the great number of multi-syllable chemical names overwhelming. I did. I confess that as the list of chemicals I was using in the construction of properties grew, I was intimidated. The list seemed unending -- an insurmountable mountain. Unconsciously, I rebelled, recognizing only the few terms I found to be absolutely necessary. I became comfortable working with molding and casting materials long before I decided to sort out their various chemical names. Now, I can happily assure you that although the list is long, it is finite and that it can be simplified and conquered by grouping the individual entries according th their similarities.

USES:

Industry is still the bulk consumer of most chemicals. Typically, manufacturers like to sell their product in 50 gallon barrels an dresis packaging them in gallon sizes for the hobbyist and the theatre technician. Still, there are some companies who cater our needs by packaging the chemicals in smaller units, but there is a price increase for the service.

TOXIC RISKS:

Certain chemicals have been recognized as dangerous if used without safeguards. The manufacturer, acting responsibly, attempts to change the compound when he can, designing the hazardous out. Some manufacturers have gone so far as to drop certain products from their line considering them to risky to sell. Remarkable, there are several solvents which have been in common use for many years and can still be purchase din the hardware store, even thought they are dangerously poisonous. These products are so useful, they remain on the market with safety warnings and explicate directions on how the product should be used.

It is important to realize that you, the consumer, have a responsibility too. No one has more reason to be interested in your health than you yourself. You must become aware of health hazards, and decide whether you want to run the risk of using particular products. In many cases you can choose a less toxic material.

Be aware that for almost all products "Material Safety Data Sheets" (MSDS) are available from the distributor or manufacturer of each product. It is definitely worth the time and trouble to acquire the MSDS for products you are using -- or contemplating use. The MSDS will provide detailed information on the risks of using each product along with appropriate details on how to deal with storage, spills, fire, and first aid.

FOAMS

Several plastics can be expanded to form a product available as either ridged or flexible foam. In my early years, I lumped all sold materials into a single bag and mentally labeled it "styrofoam"; if the foam happened to be flexible, I called it "foam rubber"! This was, of course, an erroneous simplification.

Foamed plastic in a rigid form is widely used in manufacturing for heat insulation and flotation devises. Industry uses flexible foam for insulation, air-tight sealing, and for mattresses and cushions.

Only three products are of major interest to the theatre craftsperson:

Polystyrene foam -- Dow Chemical owns the trademark "Styrofoam" but several manufacturers are producing expanded polystyrene. This foam is available in two basic formulations, easily identified by their color: white and blue. White styrene foam will burn and is doubly dangerous in a fire -- it not only flames, but in the process it produces a black smoke containing toxic styrene gas. Blue foam is flame resistant.
Urethane foam -- Urethane is probably the most useful foamed product to the theatre technician. It can be purchase din a variety of sizes, in both flexible and rigid form. A two-part liquid kit, to be expanded by the consumer is also available. On factor that adds to the confusion of understanding plastics is that the same plastic may appear in many different forms. Polyurethane is one such product -- it is available as a foam, as an unformed solid, and as a rubber compound. The rubber product is explained below in the section on thermoset plastics.
Rigid urethane foam -- Rigid urethane foam is widely used in the theatre for constructing lightweight stone work and cornice moldings, in sculpting figures, and making turned balustrades.
Flexible urethane foam -- This product is used in the prop room as it is in industry for making cushions and doing custom upholstery.
Two-part urethane kit -- Liquid urethane and a foaming agent are mixed to make a rapidly expanding foam in a variety of densities. When the

urethane begins to foam, it is poured to make free-form rocks and bread stuffs. Or it is formed by pouring the foaming liquid into a mold to make very controlled castings. The two-part urethane kit must be used with strict safeguards. In the liquid state these chemicals are dangerous to eyes and skin, so you must protect yourself by wearing gloves and goggles. The gas produced when you mix the components is toxic, so you must protect your lungs by wearing a respirator and working in a fresh air environment.
Polyethlene foam -- This foam comes as a round rod in a wide range of diameters from 1/2" to 6". It is flexible and is used in industry as an insulator and sealant. The scene technician fins this product very useful because of it flexibility in making curved moldings. He splits the rod down the middle on a bandsaw and uses it to make 1/2 round moldings. It can be split a second time and be used to make flexible 1/4 round moldings.

THERMOSET PLASTICS

Thermosets are a class of liquid resins which solidify to a permanent shape when mixed with a catalyst. Of the several resins that fall into this class, the theatre craftsman will not likely need to be concerned with more than these -- polyester resin, epoxy, and the room temperature vulcanizing (RTV) resins urethane and silicone.

Polyester resins -- When you hear the word "polyester" you may be led to think of a fabric, useful for making suits. It might seem unreasonable to find any relationship between the "fabric" and "casting resin." However, the threads in the suit and the resins packaged for molding and casting projects are indeed based in the same chemistry. There is a whole family of polyester resins, each compounded to fill a slightly different purpose.
Casting resin -- Polyester casting resin, as its name suggests, is used in casting figurines and three dimensional objects in a mold. The resin is mixed with a catalyst -- MEK peroxide -- to harden it. The curing is usually accompanied with some detectable heat, especially if the casting is large. Small castings require more catalyst and a longer curing period. Casting resin is usually clear, but it can be colored by adding dyes. You can reinforce the casting by adding glass fibers to the resin; however the job of making a strong fiberglass lamination is left to a slightly different formulation called laminating resin.
Fiberglass -- Fiberglass is just that. It is glass spun in a fiber so fine that it has lost its most familiar characteristic -- it doesn't break, it bends. The fiber is woven into cloth of several weights. It is pressed into a mat, or it is just packaged in loose chopped lengths. The cloth, mat, and the chopped fibers are used to reinforce resins -- most commonly polyester resin. The term "fiberglass" can refer to either the raw glass fibers or the finished lamination after the glass has been combined with resin.
Laminating resin -- Very strong castings with a thin cross section are made by saturating fiberglass cloth with polyester laminating resin. The resultant casting is remarkable strong for its weight, so much so that automobile bodies can be made of sheets of laminated fiberglass cloth. Boats, bathtub and shower stalls, and swimming pools are also made of laminated fiberglass. In the theatre we make armor, breastplates, masks, or any article we want to be thin, lightweight, and extremely durable. We also take advantage of the watertight properties of fiberglass by using it to line stage fountains and wading pools.
Plastic body filler (bondio) -- Polyester resin is sometimes mixed with fillers to make a putty. One popular product carries the tradename Bondo -- the name has become generic to cover all plastic body fillers. It bonds to metal and plastic surfaces and is produced for the auto body repairmen to fill small dents in hoods, fenders, doors, etc. The theatre technician finds this product very useful as a casting material, for making textures, or like the auto repairman, good for filling imperfections in metal and plastic.
Epoxy resins -- This is another family of resins having a similarity to polyester resin. The epoxy adhesives and putties are especially useful to theatre technicians.
Casting resins -- This resin hardens to a solid mass, accompanied by heat, when mixed with a catalyst. It is a little less toxic than polyester (not much), a little stronger (not much), and more expensive. Epoxy casting resin can also be used with glass fibers to make a very strong fiberglass casting.
Epoxy glue -- Epoxy resins stick to almost any surface making them a wonderful fast-setting adhesive. Most everybody is familiar with "five-minute epoxy" which comes in two tubes, an epoxy resin cement and a hardener.
Epoxy putty -- A putty carrying the tradename JB Weld unites tenaciously with metals and is used to bond such surfaces together. Another putty called Gapoxio has the consistency of modeling clay and is hand workable. Plumbers use the putty to repair minor water pipe leaks, even in the presence of water. This putty can also be used like clay to make small sculptures that set up to be permanently hard within an hour.
RTV rubbers -- There are two thermoset rubbers of significant interest to theatre crafts and are used in molding and casting. They carry the letters RTV (room temperature vulcanizing) which means that they vulcanize at room temperature without external heat.
Silicone RTV -- The best molds are made from silicone RTV casting rubber. This rubber has reproductive qualities better than could ever be required for theatre applications. It is tough, durable, resistant to high temperatures, and reasonably safe to use. The major drawback is the cost. It is a rather expensive product.
Urethane RTV -- Reasonably good molds are made from urethane RTV rubber. The big attraction of this product is its price. The reproductive traits are certainly good enough for stage purposes, but, as it is more toxic than silicone, a respirator must be used.

Thermoset plastics must all be used with prudent safeguards. All catalysts used to cure the various resins are corrosive, attacking skin tissue with a vengeance; your eyes are particularly sensitive to damage. Gloves and goggles must be worn. Polyester products are the most dangerous of the thermoset plastics. Polyester resin is suspected of being a carcinogen, and in California the packaging containers must carry a warning label. Even if this product is eventually proven to be cancer-free, we know that the fumes of the resin are harmful to the linings of the lungs. A respirator and ventilation are required.

THERMOPLASTICS

Thermoplastics are a broad class of plastic materials that are sold at room temperature but will soften when they are heated. The plastic can be shaped while it is soft and it holds the new shape when it is cooled. The process can be repeated again and again, a great number of times, before the material finally breaks down.

Sheet thermoplastics -- Several plastics, available in sheet form, can be shaped in a vacuum forming process. Clamped in an open frame, the sheet is heated to its softening point. The soft sheet is then placed over a solid object and a vacuum is applied to remove any air existing between the sheet and the object. This forces the plastic to hug close to the pattern. When the sheet cools, it retains its new shape.
Styrene -- The most common plastic to be used in the vacuum forming process is high impact white styrene. It is available in many thicknesses from 10 - 80 mil. The most useful thickness for prop and scenic use if 30 - 40 mil.
Acrylic (Plexiglas) -- Sheet acrylic is clear, and since it will not shatter in a dangerous way, it is used to make window panes for theatrical settings. This sheets of this plastic can be cast in the vacuum-forming process to make clear objects.
Mylar -- Aluminized mylar is highly reflective and can be used to make mirrors. One product is called "heat shrink" plastic. This sheet is stretched and stapled to a wooden frame. As heat is applied to the sheet it shrinks enough to remove all remaining wrinkles, and the resulting sheet is an inexpensive flaw free mirror.
Solid thermoplastics -- There are several thermoplastic casting materials, in the form of pellets or a molded sheet. It is likely you can go entirely through your theatrical career without being called on to know the chemical names, they are simply known by their tradenames Friendly plastic, Hexcelite, Protoplast, Vara-form, and others. You needn't bother with the chemical names for these plastics unless you have a strong interest -- but if you do have the interest, know that they are mostly from the polyolefin family including polyethylene and poly propoylene. Friendly Plastic is a polyester pellet, formulated to work as a hot melt.
Hot glue (ethyl vinyl acetate) is another solid thermoplastic but you will get along just fine calling it hot glue.

There is not a lot to say about the safe handling of these materials. Some fumes with a detectable odor are produced when the plastic is heated, but they are more irritating than poisonous. The only really danger is encountered when you never heat a thermoplastic and it begins to burn. A black smoke is produced which is toxic and dangerous.

LATEX RUBBER

The milky white juice of certain rubber trees is the main ingredient in latex rubbers. This is one product that has been developed with the theatre in mind. The material is appreciated by prop builders as they work on molding and casting projects and by the make-up artist. Latex rubber differs from the RTV rubbers mentioned earlier in that the liquid cures to a flexible solid mass without the introduction of a catalyst. Curing takes place as a solvent is removed from the compound through absorption and/or evaporation.

Casting latex and neoprene -- These robbers are used to make flexible castings by pourint the liquid rubber into a plaster mold. The plaster absorbs solvent from the mixture and the casting is cured as a result of htis blotting and air drying.
Filled latex -- When the latex is mixed with clay fillers, the castings have more body. The walls of the casting are thicker and the object loses a considerable amount if its flexibility.
Foam latex -- A kit consisting of four separate chemicals is on the market used for making masks and other thin wall castings. It is usually poured into a mold that has internal and external walls and the foaming latex misture is formed between the two walls. This process does require external heat to cure the casting.
Balloon latex -- This is a compound that is almost pure latex. It is painted or sprayed in extremely thin coatings for maximum stretch.
Cosmetic quality latex -- This latex is applied directly to an actor's face to make scars, warts, and other blemishes as well as entire prosthetic appliances (noses, ears, etc.)

POLYVINYL ACETATE (PVA)

You may, in this world ot toxic chemicals, wonder, "Are there no chemical products I can use with safety?" Yes, bless your heart, there are! The following adhesives and textured coatings are in a class of their own -- and are wonderfully benign.

White glue -- PVA has been formulated into several white glue products, some water soluble and some that are highly water resistant. One well known tradename is Elmers.
Flex-glue -- An adhesive long used in binding books has recently found a place in the hearts of prop builders and costumers because it remains flexible after it dries. It never hardens. One product that is packaged specifically for the theatre craftsman goes by the trade name Phlex-glu and is used for far more than just an adhesive. It is employed as a paint binder, a texturing agent, an embedding medium, and a coating material.
PVA texture coating -- PVA is so good a making textured surfaces that thick formulations are being devised specifically for theatre craftsmen and artists. One such product that has gotten popular in the lst two or three years is Sculpt-or-Coat. It began as a coating to drape and stiffen fabrics. It was found to give foam sculptures a smooth surface, and then the product grew in the hands of enthusiastic users to be very versatile.

SOLVENTS

The last category is solvents. Solvents are among the most toxic chemicals in common use. These can be all the more insidious, because so many people are already acquainted with most of the materials and erroneously consider them to be old friends. The following list is roughly arranged in the order of relative toxicity. It is well to note that almost all solvents can dissolve the natural oils from your skin and is almost all cases you should protect your hands with rubber gloves.

Water -- This most common solvent if often overlooked because it is so very common. Water and detergent should be used in mayn decreasing operations where alcohol, paint thinner, or acetone are typically used.
Alcohol -- Alcohol is used as a fuel, a thinner for shellac, and as a solvent for several dyes. It should be used in a large open space to prevent a build-up of fumes in the atmosphere.

Paint thinner -- Sometimes known as "spirits," This is a thinning agent for oil based enamel paints, and a solvent frequently used for cleaning greasy objects. It should be used in an open space or a ventilated area.
Ammonia -- This household cleaning agent is also used as a stabilizer and solvent in latex casting rubbers. A respiratory irritant, it must be used in a well-ventilated area even if used in small quantities. In larger concerntrations, you must use a respirator.
Lacquer thinner -- It is a thinning agent for lacquer and other oil based paints. Lacquer thinner is highly flammable. The fumes from this thinner are an irritant of the respiratory tract and the central nervous system, and the product should be used with forced ventilation and a respirator.
Acetone -- Acetone is a thinner for contact cement, resins, and plastics. it is dangerously flammable. Although acteone is extremely volatile and requires forced ventilation and a respirator, it is the least hazardous of the ketone class.
Gasoline -- A fuel and a degreasing agent, it should never be used except as a fuel for automobiles because it is highly flammable and may even explode.
MEK (methyl ethyl ketone) -- An extremely dangerous slovent. It is a very volatile liquid that quickly fills the air with toxic fumes that can cause permanent damage to the central nervous system. Use actone with proper precautions as a substitute for MEK.
Carbon tetrachloride -- This chemical was in common use in the past as a dry cleaner, spot remover,, and fire extinguiaher. The fumes are poisonous and capable of casuing liver cancer. Do not use.
Benzene (benzol) -- This solvent is a carcinogen causing leukemia. It is rarely used in its natural state, but can be found in some cutting oils, gasolines, and dyes. Be on the lookout for benzene and do not use.