Safe Boat Building

(How Chemicals Affect Us in the Shop)

By David Carnell

A 40 year veteran of Dupont's Chemical Safety Dept.

Chemicals are commonly perceived as a small class of nasty dangerous materials when, in fact, the universe is completely chemical and every event from creation's "big bang" to the thrill a beautiful boat evokes is the result of a chemical reaction

Any human activity has risks and no material we work with is harmless. Building and maintaining boats safely requires knowing the risks and hazards and working with respect, not fear. This is not easy for the amateur or small professional boat builder. His shop is dusty and poorly ventilated. He does not have clean, reliable, proper protective equipment and may not use what he has. He uses a whole mix of potentially hazardous materials about which he has little practical, understandable safety information.

Understanding is the important part of reducing risks and hazards. We have to know why we do what we have to for a safe workplace.

I have summarized it all in four basic principles of handling hazardous materials. They are:

Protect Your Eyes!
Don't Breathe Them!
Don't Get Them On You!
Don't Eat Them!

Protect Your Eyes: Wear at least safety glasses whenever you handle chemical materials and whenever you work with hand tools or machines. A chemical splash or a fragment thrown by a tool can blind an eye. Please protect your eyes. How would you work without them!

Wrong way(left) and Right Way (right)to work on your boat

Don't Breathe Them: Don't breathe the vapors (fumes) of materials you are using. Don't breathe dust or smoke. If you smell anything you are working with, you need better ventilation or protective equipment. Pay attention when you first smell something; your nose quickly becomes insensitive to even strong odors and then you may no longer be aware of your exposure.

Ventilation is the best way to prevent exposure. Working outside in a breeze is natural ventilation. It can be excellent, but can also fool you if the breeze bounces off your work and carries fumes back to you. You start thinking about mechanical ventilation and the first stated requirement is explosion-proof motors. The price of that kind of equipment is higher than the costs of your tools, but there are a lot of inexpensive fans and blowers around whose motors cannot spark. Box-type window fans and the small centrifugal blowers all use shaded-pole motors, which have the starting winding wired in permanently and no starting switch to make a spark. The "breeze-box" window fans are especially good for small shop ventilation. They are inexpensive, lightweight, move large volumes of air, and can be easily positioned to ventilate most situations.

Try to arrange the fan so that it pulls fresh air past you, over the work, and away from your work area. While designed to run in the vertical position, they operate horizontally as well. Working inside a boat, you can lay the fan over a hatch pointed away from you and the work and pull out the vapors while pulling fresh air in.

There are dangers of fire and explosion with the many flammable solvents and products used in boat building. Before vapor concentrations in your whole shop would reach the flammable limit, you would be unconscious (maybe dead) from the toxic effect. Flammable (explosive) concentrations exist only close to the flammable liquid or in special situations such as dense solvent vapors flowing along a floor to an ignition source like a pilot light or a motor.

Good ventilation reduces the likelihood that flammable vapor concentrations can occur anywhere in your shop. Smoking is out of place in any boat building shop. Before you use propane torches or other open flames make sure all flammable liquids are sealed up out of the way. Consider also that your stationary power tools spark each time you turn them on and many portable power tools are continuous spark producers from the brushes of their motors.

If you must use protective equipment instead of ventilation to breathe clean air, a dust mask is the minimum protection, but a dust cartridge is better. Always wear a dust mask or respirator when sanding or grinding any material; wood, fiberglass, resin, metal. Wear dust protection when handling fine powders. Protection against vapors requires cartridges that chemically

absorb the vapors. Be sure the cartridge is the right kind and be sure it is effective. Test effectiveness by putting the respirator on and breathing near a source of the vapors; you should not smell any. If you start the job with a good cartridge, it may become loaded while you are working and your nose may not detect the gradual leakage of vapors. Good ventilation is the best control.

Don't Get Them On You: Keep all solvents, paints, adhesives, sealers, etc. off of your skin. Your hands are most exposed, but you may expose other parts of your body and not realize it, especially by spills on your clothing (including shoes). For most boat building situations, impervious gloves would appear to be the perfect solution, but there are problems with gloves.

Different chemicals require gloves of different materials for best protection. The kind of glove required is hard to pick when so many safety data sheets say to use "appropriate" or "impervious" gloves. Many of you are going to be buying gloves in your drugstore, supermarket, or hardware store. The latex or rubber glove made in Malaysia or some other remote country is reasonable protection against epoxy resins and acetone, but not good with polyester resins, toluene, lacquer thinner, and most paint removers.

Vinyl gloves will protect against epoxy resins, but are poor with most solvents; especially acetone. Heavier gloves of rubber, neoprene, or nitrile rubber give better protection but are more difficult to work in and are much more expensive. The thin disposable gloves of polyethylene are resistant to most materials but are so clumsy and so easily punctured or torn that they are not of much use. Medical examining gloves come both in latex and vinyl; the latex variety offers protection and they are relatively easy to work in, but, for me, the tight fit makes my hands sweat profusely even in cool weather.

All protective equipment should be kept clean, as clean as your underwear. Pulling on dirty protective clothing can give you a head start on trouble. Wash the outsides of dirty gloves thoroughly with warm soap and water before taking them off. At least, don't stick the dirty gloves in your pocket to contaminate your clothing and skin.

If your gloves or hands are dirty when you put the gloves on, or if material is absorbed through the glove, the gloves then aggravate the exposure by keeping the material in close contact with your skin and by increasing the temperature of your skin. All chemical reactions speed up as the temperature rises, including the reactions that cause burns, itching, rashes, or absorption through the skin. If you sweat as I do, it aggravates the whole situation. Look for loose-fitting gloves with a flock lining.

Any time you get a chemical on you, wash it off thoroughly with soap and water. The standard first aid procedure for chemical spills on the body, especially in the eyes, is to flush thoroughly with water for at least 15 minutes (a long time). If you spill something on your clothes, change them. Clean your protective equipment every day. You are probably not going to have a safety shower, but a sink faucet or a garden hose always ready to turn on is an essential piece of safety equipment. If you do not have fresh water, salt water is fine.

Don't Eat Them: Who would eat boat-building chemicals? You will, if you do not wash your hands and face thoroughly before that mid-morning snack, refreshing cold drink, lunch, or cigarette. The best practice is to not eat or store your food in the work area. Then wash up before you take a break to eat or drink. Chemical plant workers are more concerned about washing their hands before they go to the bathroom than afterwards.

These are the general rules for keeping out of trouble with hazardous chemicals. Let's take a look at specific materials, their hazards, and procedures for using them safely.

Wood Dust: Wood dust is the most commonly encountered chemical hazard in boat building and perhaps the most hazardous. Over 300 varieties of wood have been reported to cause dermatitis. Heartwoods are worse than sapwoods (probably because of the natural poisons they contain, which also make them more resistant to decay). The exposure limit is 5mg/m3 for all woods except western red cedar, which is 2.5mg./m3 (because one in 20 people is allergic to red cedar dust). These are exposures for 8hr. working days. The short time exposure limit is only 10 mg./ m3. The physiological reason OSHA based the wood dust limit on is avoidance of respiratory effects.

OSHA noted that the International Agency for Research on Cancer classifies furniture manufacturing as a source of "confirmed human carcinogen" and carpentry as a source of "suspected human carcinogen" in people, not mice, rats, or guinea pigs. Cancer is caused by long-term exposure to an agent. With wood dust, as with nearly all of the chemicals regulated, OSHA concluded that avoiding exposures that can cause immediate acute effects would also protect against cancer over the long term.

How much dust is that? In a 20' by 20' by 10' high shop, a half-teaspoon of fine wood dust distributed uniformly in the air would be a concentration of 5mg./m3, that is not much and is the reason you should always wear dust protection when sanding

Lauan mahogany dust may be a bad actor, too. Dynamite Payson wrote me of his allergy to it, "I just can't breathe any of the dust without half choking." A friend of mine broke out in a rash all over his body with an accompanying fever after sanding a mold plug made of lauan.

There is no limit set on fiberglass dust, not because it is harmless, but because quantitative information needed to set limits is not available. All dusts are probably harmful and should be kept out of your lungs. In addition to its own effects, tobacco smoking aggravates the effects of some dusts, including coal dust, asbestos and radon decomposition particles.

Styrene: OSHA set the average 8 hr. exposure limit for styrene at 50 pp (parts per million) to avoid narcotic effects. They set the short-term exposure limit at 100 pp to prevent eye and upper respiratory irritation. Styrene's strong odor is detectable down to O.lppm if you have just come in from breathing fresh air. Although styrene is a possible human carcinogen, the limit set to avoid narcotic effects is more stringent than to avoid cancer based on currently available data. Polyester resins may contain 35% styrene.

Epoxy Resins: Most epoxy resins have no vapor problems. The hazard is possible sensitization by the hardeners from excessive skin contact. If you work cleanly with epoxy resins you should have no problems. If you become sensitized, which may cause rashes, dermatitis, or allergy reactions, by overexposure of your skin by careless and sloppy use, it is likely not to reverse and you may not be able to go back to using epoxies. Sensitization susceptibility varies greatly among people, but is not common. In general, the less hardener required in a recipe, the more likely it is to cause sensitization; that is, 10/1 mixes are most potent; 1/1, least.

I strongly prefer epoxy resins to styrene containing polyester resins because the hazards of working with them are less and are much more easily manageable. In addition, they are superior engineering materials with respect to adhesion, reliability of curing, and compatibility with other materials such as foams, in boat building.

Toluene: Toluene is a solvent widely used in paints, thinners, paint removers, and other solvent based materials boat builders use. The 8hr. average limit for exposure is set at 100 pp in air, with the short-term limit only slightly higher at 150 pp. Avoidance of narcotic effects is the reason for the limit, with concern to avoid even brief exposure to high concentrations. Like most solvents, toluene defats the skin and makes it sensitive to dermatitis. For gloves, only BunaN and nitrile rubber are reasonably impervious to toluene.

Acetone: Acetone is commonly used for cleaning up. Don't use it if you value your skin. It defats the skin and is absorbed through it. It is also probably the most flammable material commonly found in a boat shop. Waterless hand cleaners are better cleaners for your hands.

What's a Boat builder to Do? The best all-around advice is a combination of statements from boat building product literature: "None of our products is safe. They cannot be made safe. Work cleanly." Get material safety data sheets (MSDS) when you buy boat building materials. They are difficult for someone without chemical background to understand, but there is always useful information on how hazardous

Carbon Fiber Olympic Speed Skate Design by Bruce Kohe of SS Boots. Worn by 2006 Olympics by Gold and Bronze medal winner Apolo Ohno, Allison Baver, among others

the materials are, how to handle them safely, what protective equipment is needed, first aid and contacts for help in an emergency situation. Always stop and think about how you are doing a job and how you may get into trouble.

How To Get Help From Material Safety Data Sheets: The information required in Material Safety Data Sheets is generally specified by OSHA. The specifics, the detail, and the manner of presentation are left up to the manufacturers and distributors; for the same chemical, different sources will publish MSDS that are quite different in format though the essential data will be the same.

The sheets may be incomprehensible at first glance to persons without some knowledge of chemical and physical principles and the descriptive jargon of toxicology and chemical hazards. The information is presented in a standard order and the boat builder should look for:

Emergency Number: There will be at least an emergency telephone contact for medical help.

Material Identification: The chemical nature of the material. Numerical ratings of the hazards in terms of health, fire, and reactivity. These will be numbers from 0 to 3 (3 is the greatest hazard). Generally, health and fire are your greatest concerns.

Components: The lesser materials and impurities present.

Physical Data: Information on color, odor, taste, and quantitative data, which can tell you a lot about hazards of working with the material.

Vapor pressure: This number can tell you a great deal about the ventilation requirements and fire hazards of working with the material. It is given in mmHg (millimeters of mercury) at 20 degrees C. (68 degrees F). Values for typical materials are: Water, 17; acetone, 181; styrene, 6; epoxy resin, <0.1, toluene, 22. These are saturated vapor pressures, what you have in the vapor space over the liquid in a sealed and part full can. The higher the vapor pressure, the greater the possible toxic exposure, fire hazard and the better ventilation required.

Protect Your Eyes!

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