Hazards of Fiberglass Layup and Sprayup

Minnesota Department of Labor and Industry
Occupational Safety and Health Division

Adapted from *Fiberglass Layup and Sprayup – Good Practices for Employees* (DHHS (NIOSH) publication number 76-148), by National Institute for Occupational Safety and Health. (1976). Cincinnati, OH: Author.

INTRODUCTION

Minnesota OSHA experience shows that employees in fiberglass resin plastics manufacturing are exposed to multiple hazards – high levels of styrene in lamination operations, noise in spray booths and grinding areas, and dust from grinding operations. In addition to chemical vapor and noise hazards, employees may be exposed to burns from eye or skin contact with catalysts used to initiate resin curing. Carpal tunnel injuries can occur among employees using rollers. This booklet discusses some recommended work practices, presents case studies from several plants, and provides information on OSHA standards that apply to these industries**.**

WORKING WITH EPOXIES

Special precautions and work practices are required when working with epoxies:

- Read the labels on all containers and the Material Safety Data Sheets (MSDS) for information on health or fire hazards. If you have any questions about the kinds of chemicals you use, ask your supervisor.

- Always mix components in hoods that draw the vapors away from you.

- Protect your skin and eyes from any contact with epoxies during hand layup. Wear proper gloves, face shields, chemical goggles, and coveralls. You may have to wear special rubber clothing when working with some epoxies.

- Remove any splashed epoxy from your skin immediately. Use mild soap or waterless cleansers, but do not use solvents since they can cause skin rash.

- Remove contaminated clothing immediately and do not reuse it until it has been cleaned. Epoxies can be removed from rubber clothing and gloves with a solvent, followed by a soap and water washing.

- Keep work areas clean. Use disposable cloth rags or paper towels to clean up any spills. In many plants, heavy paper is used to cover work areas and floors at the beginning of each shift. During cleanup, or after a spill, the covering is replaced.

- Keep tools free of epoxy. Disposable tools like wooden stirrers, plastic or paper containers, and throwaway rollers are best because this avoids additional contact with the chemicals when cleaning.

- Shower after each shift to remove any traces of the chemicals from your body.

RESIN, SOLVENTS AND STYRENE

Resin arrives at the plant in a liquid form, a polyester thinned with styrene monomer, and mixed with chemical inhibitors to prevent a spontaneous crosslinking reaction. Controlling the polymerization reaction requires the use of catalysts, promoters, temperature and time.

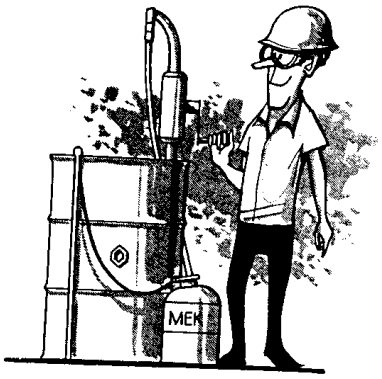
Styrene and many other different kinds of solvents are often used. Accidents and health problems may occur from misuses or improper handling of these solvents, as well as from exposure to styrene. If you are handling styrene or solvents and experience any eye discomfort, breathing difficulty, or other type of symptom, tell your supervisor. Permissible Exposure Limits have been set by OSHA and they establish the amounts of different chemicals that you can be exposed to in an 8-hour work shift. The MNOSHA Permissible Exposure Limit for styrene is 50 parts per million (ppm).

Styrene monomer and most of the commonly used solvents such as acetone and MEK (methyl ethyl ketone) can form flammable or explosive vapor concentrations under normal room temperatures.

Good work practices to follow when working with solvents and styrene are:

Ventilation: Always work with adequate ventilation.

Fire Protection: Exclude all possible sources of ignition for areas where solvents are used or stored. This means there must be no smoking, open flame, welding, burning, hot machinery, or electrical equipment not designed for this special use in any areas where flammables are used or stored.



Use a ground and bond when transferring flammable liquids.

Dispensing: Prevent static electricity build-up when transferring solvent from a drum to a

container by grounding the drum and the container to form an electrical bond. (Just as static builds up when you run a comb through your hair, a similar charge can build up when the molecules of a solvent rub together as the fluid is being poured. This is why the drum must be grounded and the receiving container bonded to the drum.) A metallic cable is usually used for grounding. It is bolted or clamped to a ground conductor on one end and has a screw clamp or clip to attach to the drum on the other end. Be sure to scrape any paint, dirt, or rust from the part of the drum where you are going to attach the ground. The receiving container must also be attached to the drum with a bonding wire.

Handling: Carry solvents in safety cans and dispense from them. Take only the amount of solvent be used during a shift into the work area. Unused solvent must be returned to approved storage at the end of the shift.

Cleanup: Clean up all solvent and styrene spills immediately. There are special compounds such as vermiculite, perlite, clay, and dry sand which will absorb spilled solvents. Cleanup of large spills (spills requiring the efforts of more than one person, or as defined by your employer) may be considered emergency response operations. In these instances, employees must not respond unless the appropriate training and protective equipment are provided. Follow the specific spill cleanup instructions provided by your employer.

CASE HISTORY: The Not-So-Empty Drum

A supervisor wanted an old drum to use as a garbage can at home. He went to the shipping and receiving clerk who let him pick out an empty 20-gallon solvent drum despite a company rule that no drums be reused without decontamination. The supervisor asked a welder to cut the top off. The welder removed the bung and was adjusting his torch to begin the cut when the drum blew apart. A fragment partially severed the welder's jugular vein but prompt first aid by a coworker saved his life.

What went wrong? The drum apparently contained a small amount of solvent that the heat from the torch caused it to explode. The drum had not been cleaned thoroughly enough and there remained flammable solvent vapors creating an explosive atmosphere when exposed to heat.

CASE HISTORY: Static Charge Triggers Fire

Two workers were using a hand pump to empty a small amount of solvent remaining in one drum into a second drum. While one worker was turning the hand crank on the pump, the second was aiming the pump spout into the bung, but the spout was not touching the drum. The drums exploded. Both men and a fellow employee were severely burned in the fire that followed.

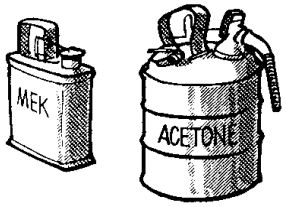
What went wrong? A static charge buildup as the free falling solvent was being transferred and ignited the flammable vapors. Bonding straps were not used to prevent buildup of static charges.

ORGANIC PEROXIDES

The basic rule for handling organic peroxides is follow the manufacturer's directions carefully!

Organic peroxides are used as catalysts and can be dangerous. **HANDLE WITH CARE.** The various peroxides differ considerably in their chemical properties, but can all be unstable and require special handling, storage, and mixing procedures. They may explode from friction, static electricity charges, contamination with other materials, improper mixing procedures, or from charges brought about by freezing, evaporation or aging. In addition to the dangers of fire and explosion, skin or eye contact can produce severe irritation or chemical burns. There are special guidelines to follow for mixing and dispensing, spraying, storing, and disposing of organic peroxides.

REMEMBER: FOLLOW ALL of the manufacturer's directions.



MIXING AND DISPENSING ORGANIC PEROXIDES

- Users and handlers should have special training in mixing and dispensing.
- Always wear chemical splash goggles and protective gloves. A good practice is to work behind safety shields or in hoods with safety glass fronts. Ventilated hoods or respirators approved for organic vapors are necessary for some formulations because of the solvents they contain.
- Never mix peroxides directly with accelerators or promoters. A violent explosion can result.
- Keep all work areas, tools, and containers clean. Avoid mixing contaminated peroxides with any other substance.
- Weigh and mix in a special room or area apart from other plant operations. Never use a storage area containing other peroxides. The mix area should be well-ventilated and have sprinklers.
- Know the location of the nearest emergency shower and eye wash in the mix areas.
- Adding peroxides to hot resins is dangerous. Be extremely careful during this operation.
- Never dilute peroxide solutions. Using the wrong solvent or a contaminated solvent can cause a violent reaction.
- Mixing and dispensing containers should be polyethylene, Teflon, glass, or stainless steel 304 or 316. (Brass, copper, zinc, galvanized finishes, and some steels and aluminum alloys are corroded by peroxides, and this corrosion can trigger a peroxide fire or explosion. Paper

containers and wooden stirrers are good for one-time use.)

- Never return excess peroxides to storage containers. Do not use glass for storage, as any pressure buildup can shatter the container.
- Keep all containers tightly closed to prevent contamination.
- Use an electrical ground and bonding strap with any processing equipment.
- Do not use acetone to dilute peroxide solutions or to clean containers or tools. Acetone reacts with some peroxides to form explosive compounds.

SPRAYING WITH ORGANIC PEROXIDES

- Keep your equipment clean and properly maintained with covers in place.
- Avoid contaminating the organic peroxide when filling dispensing containers. Sanding dust and resin over spray are serious sources of contamination.
- NEVER smoke in a spray area.
- Keep dispensing containers away from any sources of fire or heat.
- Be sure that the vents of all pressure pots are free of over spray. Vents that are too small or closed because of over spray buildup cannot work properly.
- Wear eye protection.
- Avoid breathing overspray – always use the ventilation system and if necessary, wear your respirator.
- Never test-spray peroxide solutions into the air or onto resin overspray. Make all test shots into water.
- Be sure that all spray gun parts that come in contact with peroxides are stainless steel 316.
- Use only original replacement parts. Replacing screens or other parts with copper or other metals that are corroded by peroxide can result in fires or explosions.
- Never point a spray gun at yourself or anyone else.

STORAGE OF ORGANIC PEROXIDES

- Store in the manufacturer's shipping containers. Repackaging is dangerous.
- Be sure containers are completely emptied and cleaned before disposal.
- Destroy empty containers. DO NOT reuse.
- Keep only the quantity that will be used during the shift in the plant.
- Store organic peroxides apart from all other materials.
- Keep all containers labeled and tightly closed to avoid contamination.

DISPOSAL OF ORGANIC PEROXIDES

Waste, spilled and expired peroxides should be disposed of in accordance with local hazardous waste laws.

CASE HISTORY: Sprayup Man Loses Leg

A sprayup plant was diluting MEK peroxide catalyst using reclaimed acetone. A two-gallon pressure pot exploded, and the operator lost a leg.

What went wrong? Three different safe handling rules were violated in this accident.. First, manufacturers strongly warn against users doing their own dilution. Secondly, acetone must never be used with MEK peroxide, and lastly, use of a reclaimed solvent, which could have contained contaminants, increased the hazard. All pressure pots must be equipped with a good vent and kept clean.

CASE HISTORY: Fire Sweeps Plant

At a plant manufacturing fiberglass reinforced plastic products, a special room was used for all mixing. Mixing was done at a long bench with a liquid peroxide catalyst station at one end and the accelerator dispenser located at the other end of the bench. The man in charge of the mixing was usually careful about his housekeeping, but on one summer's day, he used the same cotton rag to clean up spilled catalyst and accelerator. The rag spontaneously caught fire, the flames spread rapidly, and the plant was destroyed.

What went wrong? The mix man knew the danger of mixing organic peroxides and promoters or accelerators but carelessly combined them on his cleanup rag. Never mix peroxides directly with accelerators or promoters because fire or explosion can result. The accident could have been avoided if

rags were only used once, or if rags were color coded to help prevent accidental contact of the chemicals.

DUSTS

Dust from flashing removal, finishing operations, sanding joints, or repairing defects can irritate your skin, nose , throat, and lungs. Workers in finishing areas should work in booths with mechanical exhaust ventilation or use tools that collect the dust as it is generated. If this is not feasible, they should wear dust respirators. Wearing long-sleeved shirts is also recommended to keep the dust off the skin. If high dust levels are expected employees should wear protective clothing over their street clothes. NEVER use compressed air to remove dust from your clothing. This practice contaminates the air with dust and presents an eye injury hazard.

Even when heat treated, epoxy resins are often not completely cured when you start finishing operations. These uncured resin dusts can give you allergic reactions and asthma-like problems. Some people may develop skin reactions.

VENTILATION

Proper ventilation in conjunction with good work practices is the most important key to preventing airborne hazards from reaching you. There are some standard variations of the two basic types of ventilation – general dilution and local exhaust systems.

GENERAL DILUTION VENTILATION uses fans to exhaust air from a room or building and to keep air contaminants at a low level by diluting contaminated room air.

LOCAL EXHAUST SYSTEMS are the most effective. They move the air toward a hood, pulling contaminants along before they reach the breathing zone of the operator. But the effectiveness of local exhaust systems is greatly reduced as you move the work away from the hood. A hood 12 inches from the sources of the contaminant is only about one-fourth as effective as a hood 6 inches away.

Effective local exhaust systems should pull contaminants away from the worker’s breathing zone. The following are some examples of local exhaust ventilation systems:

SPRAY BOOTHS are recommended for sprayup, gun wetting, and rollout operations. The spray booth exhaust system operates to draw vapors away from your breathing zone. The National Institute for Occupational Safety and Health (NIOSH) recommends a minimum air flow rate of 200 feet per minute through the booth to control styrene exposure levels. OSHA requires a minimum of 100 feet per minute air velocity across the face of the spray booth.

AN EXHAUST BOOTH or VENTILATED TABLE is recommended for mixing and compounding. These operations should be done in an exhaust booth, on a side-draft or down-draft table, or at a lateral slot exhaust table. If you must use an overhead canopy hood, do not lean over your work – the exhaust may draw vapors past your face.

Shaping and finishing after parts have hardened are best done in an exhaust booth. Grinding or cutting tools (portable sanders, grinders and saber saws) can also be equipped with low-volume, high-velocity exhaust systems. These small exhaust systems are mounted on the tool and the contaminated air is exhausted away through a small hose.

Recommended work practices include always standing upstream of the object being sprayed. A turntable can help with access to very large objects, without placing the sprayer between the part and the ventilation fan. Extension arms on spray guns should be used to for hard to reach cavities, to prevent employees from leaning into sprayed molds.

POSSIBLE HEALTH EFFECTS

DERMATITIS

The most common health problem of lay up workers is a skin condition called dermatitis. Poison ivy contact, for example, is a dermatitis reaction with which you may be familiar. Dermatitis can range from a slight reddening of the skin and a mild itch to rashes, open, oozing sores, and intense pain. In advanced cases, it becomes almost impossible not to scratch open the inflamed blisters, causing the skin to become infected, scaly, and deeply cracked. Prompt medical attention is the best way to keep a slight irritation from becoming severe.

The only sure way to prevent dermatitis is to avoid contact with chemical irritants. People vary in their reaction to these chemicals, depending on several factors including skin color or the amount of oil in their skin. The reaction always breaks out where you touched the irritant and does not spread beyond the irritated area, unless transferred by contaminated hands. It usually will go away with time when contact stops.

SENSITIZATION

Sensitization is an allergic reaction that some layup workers can develop suddenly after years of handling a material without any reaction. Once you are sensitized, contact with even a small amount of the same material can cause a severe outbreak that may spread widely over the body. Some sensitization reactions can also affect the respiratory system, resulting in asthma-like problems or coughing spells. You seldom lose this sensitivity, and sensitized workers frequently must leave their jobs or be transferred to other areas. Avoid direct contact with all resins, hardeners, catalysts and additives used in layup and sprayup; they are all possible sensitizers. The uncured resin dust from finishing operations also can cause these allergic reactions. Because sensitization starts so suddenly, it is extremely important that you limit contact with all chemicals even though they may not bother you now.

GLASS ITCH

Another skin problem, glass itch, is caused by fibers from glass reinforcing products rubbing on the skin and irritating it. Glass fibers can also be so fine as to cause respiratory problems. Most new workers stop itching after a week or so on the job. However, the itch may temporarily return after your vacation or if you miss work for long periods.

CHEMICAL BURNS
Mucous membranes are very sensitive to chemical exposures, and eye contact with chemicals should be avoided by the use of safety goggles. In the event of a chemical splash to your eyes, you should go to the nearest eyewash and flush your eyes for 15 minutes.

RESPIRATORS

Approved respirators must be worn where ventilation is not adequate, after all attempts have been made to provide adequate ventilation. The respirators must be chosen for the particular job, fit right, and they must be properly worn and maintained. Employers must develop a written respirator program when respirators are provided in the workplace.

If your job requires you to wear a respirator, your employer must train you in how to wear and care for the respirator. A medical determination also must be done to ensure that it is safe for you to wear a respirator. Respirators must be cleaned and checked after each use. The facepiece of your respirator must be cleaned each day, or before each use. Use mild soap and warm water. Do not use solvents, hot water, or harsh cleaning compounds. Replacement filters and cartridges and other parts must be those designed by the manufacturer for that particular respirator – do not attempt to substitute parts. Filters and cartridges should be changed as often as necessary: if it becomes difficult to breathe through them; if you detect the odor of solvent while wearing the respirator; or if they have been used for their specified lifetime. Store all respirators in a clean dry place in a sealing plastic bag, or other sealed container, preferably kept in a cabinet or locker designated for this purpose. Proper maintenance will prolong the life of the respirator.

RESPIRATOR FIT

For negative pressure respirators:

- Facial hair causes your respirator to fit poorly. You cannot have a beard with a respirator that has a sealing surface with the face.

- Do not wear regular glasses when wearing a full face respirator. The stems will break the seal.

- Adjust the respirator so that it does not dig into your face. You should not feel a lot of pressure. It should fit snugly, but still be comfortable. Check to see if any air leaks around the edges while you breathe. You should not be able to detect any styrene or solvent odor or dust. Learn how to perform a positive/negative fit check and do it every time you put on your respirator.

- Always inspect any respirator before you wear it. Be sure it is clean and in good condition and is working properly.

For supplied-air respirators:

- Facial hair causes your respirator to fit poorly. You cannot have a beard with a respirator that has a sealing surface with the face.

- Do not wear regular glasses when wearing a full face respirator. The stems will break the seal.

- Adjust the respirator so that it does not dig into your face. You should not feel a lot of pressure. It should fit snugly, but still be comfortable.

- Make sure that the compressor is equipped with all necessary safety and standby devices, and that if alarms are present, you can hear them when they are activated. The compressor must be located in an area that prevents contaminated air from entering the system.

- Air line connections must be incompatible with outlets for other gas or spraying systems in use.

CUMULATIVE TRAUMA DISORDERS (CTDS)

Cumulative trauma disorders are muscle, tendon or nerve disorders which can include; sprains, strains, tendinitis, carpal tunnel syndrome and vibration syndrome. These disorders are cumulative; which means they develop gradually over a period of weeks, months, and even years when there is repeated stress on a particular body part. Employees with CTDs may experience discomfort, pain, fatigue, swelling, stiffness or numbness and tingling in the upper extremities.

In fiberglassing operations, repetitive tasks such as hand-rolling of freshly sprayed fiberglass parts or, sanding, routing, and grinding of the edges of fiberglass parts can increase the risk of developing a CTD. Risk factors in these jobs may include; forceful exertions, awkward postures, repetitiveness, static loading or sustained exertions, mechanical contact stress from tools and sharp-edges, and hand-arm vibration. Engineering and administrative controls should be implemented to reduce or eliminate the risk factors.

In work areas where CTD rates are elevated, the employer must implement an *ergonomics program*, including a systematic method of preventing, evaluating and managing these disorders.

Normally, an ergonomics program has the following four elements: worksite analysis, hazard prevention and control, medical management, and training and education. More detailed information

on developing an ergonomics program can be obtained from any Minnesota OSHA area office.

NOISE

Minnesota OSHA requires that employers implement an effective Hearing Conservation program if exposures exceed the 8-hour time-weighted average noise level of 85 dBA (the action level). One simple rule of thumb for noise is that if in order to be heard, it is necessary to raise your voice at a co-worker who is three feet or less away, it is likely that the noise level is above 85 dBA.

Noise levels over the action level and/or permissible exposure level (PEL) of 90 dBA as an 8-hour time weighted average are likely in grinding and finishing areas. Noise may also be elevated in the gel-coat and chopper gun areas. Long exposure to loud noise causes permanent, irreversible hearing loss. Noise-induced hearing loss occurs gradually over a period of years and is often undetected by the employee. Noise-induced hearing loss is also preventable with the use of hearing protectors such as ear plugs or ear muffs.

In areas where employee's hands may become contaminated with glass fibers, it is very important that insert ear plugs are place in ears with clean hands because of the potential for fibers to be introduced in the ear canal. You should always be careful to wash your hands before handling ear plugs to avoid contamination of the ear canal.

A Hearing Conservation Program requires employers to provide: periodic noise monitoring, annual employee training, baseline/annual audiograms and hearing protection. Hearing protection is required to be worn for all workers if their average noise exposure is over the PEL and must be offered (and strongly recommended) if exposure is over the 85 dBA action level.

PROCESS SAFETY MANAGEMENT

When more than 10,000 pounds of flammable liquid or gas are stored on site in a single or connected series of tanks, process safety management regulations apply. This includes a system capable of transferring styrene directly to a chopper gun or mixing tanks. Process safety regulations require an employer to minimize the potential for a catastrophic event, such as a fire or large resin spill, by identifying and controlling potential hazards.

Styrene is a Class IC flammable liquid, and where bulk storage of resin is used to feed chopper guns or area mixing tanks, the regulations apply (when 10,000 pounds or more on site). There are thirteen required elements in a process safety management plan:

- Employee participation
- Process safety information
- Process Hazard Analyses

- Operating procedures
- Employee training, for process operators
- Contractors, evaluation and training
- Pre-start up safety review
- Mechanical integrity of process equipment
- Hot work permits on or near a covered process
- Management of change
- Incident investigation
- Emergency planning and response
- Compliance audits

EMPLOYEE RIGHT-TO-KNOW

Minnesota OSHA requires employers to develop a written program and train employees routinely exposed to hazardous substances and harmful physical agents. Training must be conducted before an employee starts working in an area with potential exposure, and annually after that. Training is required even if the employees are not overexposed to a chemical or physical agent.

Employees in fiberglass shops are routinely exposed to hazardous substances, including styrene, acetone, organic peroxides, dust, fiberglass, and isocyanates (where foaming operations are present). Harmful physical agents include noise and heat. If employees are exposed to noise or heat approaching OSHA limits, these exposures must be addressed in the training program.

Employers must maintain information on chemicals used in the workplace, and this is done by obtaining Material Safety Data Sheets (MSDS) from chemical manufacturers. MSDS must be available to employees on all work shifts. Training must include information on permissible exposure limits, health effects of exposures, symptoms of overexposures, and methods of controlling an employee's exposure. The training should allow an opportunity for employees to ask questions. Training records must be maintained for three years.

Important Terms

Accelerators Compounds added to speed up the action of the catalyst in a resin mix.

Catalyst A material used to activate the basic resins, causing them to harden. Polyester systems

mainly use organic peroxides, and epoxy systems use amines and anhydrides.

Contaminant Any unwanted impurity in air or liquids. May or may not be harmful.

Crosslinking The linking together of long resin molecules by a monomer. Also called polymerization.

Dermatitis A skin condition resulting from direct contact with an irritating or sensitizing chemical.

Exhaust Ventilation (local) Ventilation systems that draw the dusts, vapors, or contaminated air out of an area, usually with hoods.

Gel The state of the resin during the early stages of hardening prior to becoming a solid. Similar to gelatin.

Gel Coat A specially formulated resin containing color and filler materials to provide a smooth, pore-free surface for the fabricated part.

General Dilution Ventilation Ventilation systems that draw or blow fresh air into an area, thus diluting contamination in that area.

Hardener A material which is added to the resin to aid in the curing process.

Inhibitors Chemicals added to prevent polymerization of resin blends too soon.

Mold Release Agents Waxes or stearates applied to a mold to aid in the separation of the mold and the finished product.

Monomer A compound of simple structure that converts into a polymer by combining with itself or other similar compounds.

Organic Peroxides Group of catalysts most frequently used with polyester resins. Methyl ethyl ketone (MEK) peroxide is the most common type used.

Polyester Resin The family of resins most commonly used in the manufacture of fiberglass products. The monomer units are crosslinked together to form a chain structure.

Reactive Diluent A material used in an epoxy system, first to act as a solvent, thinning and dissolving resins, and secondly to enter into the hardening reaction by crosslinking with the epoxy resins.

Resin Highly reactive chemical building blocks which are transformed into a solid plastic upon activation by hardeners (epoxies) or catalysts (polyesters).

Sensitization An allergic reaction caused from exposure to a particular material. Onset of such

reactions can be sudden and may occur after as short a period as one week or gradually after a person has safely handled a material for years.

SUMMARY

If you have further questions about the information presented in this booklet, or requests for specific information on the standards mentioned in this manual, please contact your nearest Minnesota OSHA area office.

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