2. HANDLING EPOXY

This section explains the fundamentals of epoxy safety, curing and the steps for proper dispensing, mixing and adding fillers to ensure that every batch cures to a high strength solid.

2.1 Epoxy Safety

Epoxies are safe when handled properly but it is essential to understand the hazards and take precautions to avoid them.

Hazards

The primary hazard associated with epoxy involves skin contact. WEST SYSTEM Resin may cause moderate skin irritation; WEST SYSTEM Hardeners may cause severe skin irritation. Resins and hardeners are also sensitisers and may cause an allergic reaction but, from our experience, most people are not sensitive to WEST SYSTEM Resin and Hardeners. These hazards decrease as resin/hardener mixes reach full cure but it is important to appreciate that the hazards also apply to the sanding dust from partially cured epoxy. Please refer to the Material Safety Data Sheets for specific product warnings and safety information.

Precautions

1. Avoid contact with resin, hardeners, mixed epoxy and sanding dust. Wear protective gloves and clothing when handling WEST SYSTEM materials. WEST SYSTEM 831 Barrier Cream provides additional protection for sensitive skin and allergies. **DO NOT** use solvents to remove epoxy from the skin. Immediately after skin contact with resin, hardeners, sanding dust from epoxy and/or solvents, use WEST SYSTEM 820 Resin Removing Cream for the initial clean-up, followed by a wash with soap and warm water.

If a skin rash develops while working with epoxy, stop using the product until the rash completely disappears. If problems persist when work is resumed, discontinue use and consult a doctor.

2. Protect your eyes from contact with resin, hardeners, mixed epoxy, and sanding dust by wearing appropriate eye protection. If contact occurs, immediately flush the eyes with water for 15 minutes. If discomfort persists, seek medical attention.

3. Avoid breathing concentrated vapours and sanding dust. WEST SYSTEM epoxy vapours can build up in unvented spaces and ample ventilation must be provided when working with epoxy in confined areas such as boat interiors. When adequate ventilation is not possible, wear an approved respirator.

4. Avoid ingestion. Wash thoroughly after handling epoxy, especially before eating. If epoxy is swallowed, drink large quantities of water - **DO NOT** induce vomiting. Call a doctor immediately. Refer to First Aid procedures on the Material Safety Data Sheet.

5. KEEP RESINS, HARDENERS, FILLERS AND SOLVENTS OUT OF THE REACH OF CHILDREN.

For additional safety information or data, write to: EPOXY SAFETY, Wessex Resins & Adhesives Limited, Cupernham House, Cupernham Lane, Romsey, Hampshire SO51 7LF

2.2 Clean Up

Contain spills with sand, clay or other inert absorbent materials and use a scraper to collect as much material as possible. Follow up with absorbent towels.

DO NOT use either sawdust or other fine cellulose materials to absorb hardeners and/or dispose of hardener in waste containing sawdust or other fine cellulose materials—spontaneous combustion may occur.

Clean resin, or mixed epoxy residue or uncured epoxy with WEST SYSTEM 850 Cleaning Solvent. Clean hardener residue with warm soapy water.

Dispose of resin, hardener and empty containers safely in accord with local disposal regulations.

DO NOT dispose of resin or hardener in a liquid state. Waste resin and hardener should be mixed and cured (in small quantities) to a non-hazardous inert solid.

CAUTION! Large volumes of curing epoxy can become hot enough to ignite surrounding combustible materials and produce hazardous fumes. Place containers of mixed epoxy in a safe and ventilated area away from workers and combustible materials. Dispose of the solid mass when the cure is complete and the mass has cooled. Comply with the local disposal regulations

2.3 Epoxy Chemistry

Understanding cure time

Open time and cure time determine the build and repair operations. Open time dictates the time available for mixing, application, smoothing, shaping, assembly and clamping. Cure time dictates the time before removing clamps, abrading or proceeding to the next step in the project. Three factors determine the open time and cure time of an epoxy mix – *hardener cure speed, epoxy temperature and volume of mix.*

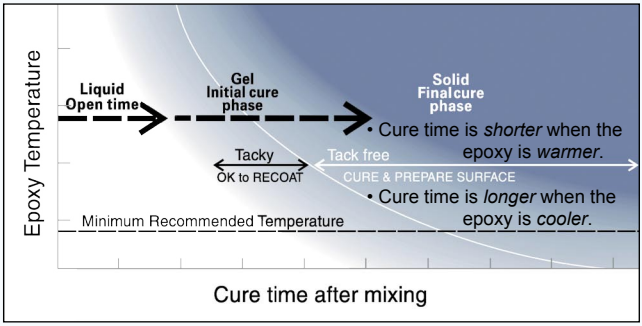


Figure 1 As it cures, mixed epoxy passes from a liquid state, through a gel state, to a solid state.

a) Hardener speed

Each hardener has an ideal temperature cure range. At any given temperature each resin/hardener combination will go through the same cure stages but at different rates. Select the hardener that gives adequate working time for the job in hand at the temperature and conditions under which the work is to be completed. The Product Guide describes hardener pot lives and cure times.

Pot life is a term used to compare the cure speeds of different hardeners. It is the period of time a specific mass of mixed resin and hardener remains a liquid at a particular temperature e.g. a 100g mass of an epoxy mix in a standard container at 25°C is a routine quality control test procedure.

Because pot life is a measure of the speed of cure of a specific mass (volume) of epoxy rather than a thin film, the pot life of a resin/hardener mix is much shorter than its open time.

b) Epoxy temperature

The warmer the temperature the faster an epoxy mix will cure *(Figure 1)*. The temperature at which epoxy cures is determined by the **ambient temperature** plus the **exothermic heat** generated by the reaction.

Ambient temperature is the temperature of the air and/or the material in contact with the epoxy. Epoxy cures faster when the ambient temperature is warmer.

c) The volume of mixed epoxy

Mixing resin and hardener together creates an exothermic (heat producing) reaction. Always mix small batches of epoxy because the greater the quantity, the more heat generated, the shorter the pot life and cure time. In a larger volume, more heat is retained, causing a faster reaction and yet more heat e.g. a plastic mixing cup containing, say, a 200g mix. can generate enough heat to melt the cup. However, if the same quantity is spread into a thin layer, the exothermic heat is not produced as quickly and the cure time of the epoxy is determined by the ambient temperature.

Controlling cure time

In warm conditions use a slower hardener to increase the open time. Mix smaller batches that can be used quickly or pour the epoxy mix into a container with greater surface area e.g. a roller pan, thereby spreading out the epoxy into a thin film and extending the open time. After thorough mixing, the sooner the epoxy is transferred or applied, the more open time is available for coating, lay-up or assembly.

In cool conditions use a faster hardener and employ a hot air gun, a heat lamp or other heat source to warm the resin and hardener before mixing and/or after the epoxy is applied. At room temperature, additional heat is useful when a quicker cure is desired. **NOTE**! Unvented kerosene or propane heaters can inhibit the cure of epoxy and contaminate epoxy surfaces with unburned hydrocarbons.

CAUTION! Warming a resin/hardener mix will lower its viscosity, allowing the epoxy to run or sag more easily on vertical surfaces. In addition, heating epoxy applied to a porous substrate (soft wood or low density core material) may cause the substrate to "out-gas" and form bubbles in the epoxy coating. To avoid out-gassing, wait until the epoxy coating has gelled before warming it. Never heat mixed epoxy in a liquid state over 50°C.

Regardless of the steps taken to control the cure time, thorough planning of the application and assembly will allow maximum use of the open time and cure time of the epoxy mix.

Cure stages of epoxy

Mixing epoxy resin and hardener begins a chemical reaction that transforms the combined liquid components into a solid. As it cures, the epoxy passes from the liquid state , through a gel stage before it reaches a solid state. *(Figure 1)*

1. Liquid – Open time

Open time (also working time) is the period, after mixing, that the resin/hardener mix remains a liquid and is workable and suitable for application. All assembly and clamping should take place during this period to ensure a dependable bond is achieved.

2. Gel – Initial cure phase

The mix passes into an initial cure phase (also known as the "Green Stage") when it begins to gel. The epoxy is no longer workable and will progress from a tacky consistency to the firmness of hard rubber. An indent can be made with the thumb nail and it is too soft to dry sand.

While the epoxy is tacky, a new application of epoxy will chemically link with it, so the surface may be bonded or recoated **without sanding**. This ability diminishes as the mix approaches the final cure phase.

3. Solid – Final cure phase

The epoxy mix has cured to a solid state and can be dry sanded and shaped. It is no longer possible to indent the surface with the thumb nail. At this stage, the epoxy has reached 90% of its ultimate strength, so clamps can be removed. The mix will continue to cure over the next few days at room temperature.

A new application of epoxy will no longer chemically link to it, so the surface must be **thoroughly washed and sanded** before recoating to achieve a good mechanical, secondary bond. *See Surface Preparation – page 11.*

2.4 Dispensing and Mixing

Careful measuring of resin and hardener and thorough mixing of the two components are essential for a proper cure. Whether the resin/hardener mix is applied as a coating or modified with fillers or additives, observing the following procedures will ensure a controlled and thorough chemical transition to a high strength epoxy solid.

Dispensing

Dispense the correct proportions of resin and hardener into a clean plastic, metal or wax-free paper container *(Figure 2)*. Do not use glass or foam containers because of the potential hazard from exothermic heat build-up. DO NOT attempt to adjust the cure time by altering the mix ratio. An accurate ratio is essential for a proper cure and full development of physical properties.

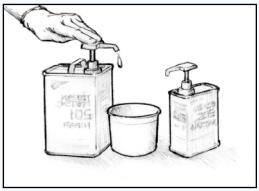
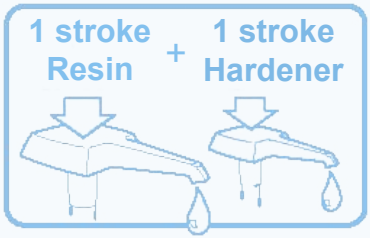


Figure 2 Dispense the correct proportions of resin and hardener.

Dispensing with Mini pumps

Most problems related to the curing of epoxy can be traced to the wrong ratio of resin and hardener. To simplify metering, use calibrated WEST SYSTEM Mini Pumps to dispense the correct working ratio of resin and hardener. (*For one full pump stroke of resin use one full pump stroke of hardener.*) Depress each pump head fully and allow the head to return completely before beginning the next stroke. Partial strokes will give an incorrect ratio. Read the pump instructions before using the pumps and verify the correct ratio before using the first mix on a project. Recheck the ratio whenever curing problems are experienced. One full depression of each pump will give approximately 30g of mixed epoxy.



With Mini Pumps - One full pump stroke of resin for one full pump stroke of hardener will give the correct ratio.

Dispensing without Mini Pumps—Weight/volume measure

To measure 105 Resin and 205 or 206 Hardener by weight, combine five parts resin with one part hardener. Small quanities can be mixed by volume at the same ratio. To measure 105 Resin and 207 or 209 Hardener by volume, combine three parts resin with one part hardener (by weight, 3.5 parts resin : 1 part hardener).

First time users

If using WEST SYSTEM epoxy for the first time, begin with a small test batch to get the feel for the mixing and curing process before applying a mix to the job in hand. This will demonstrate the open time for the resin/hardener mix at the present ambient temperature and give assurance that the mix ratio is correctly metered. Mix small batches until confident of the handling characteristics of the epoxy.

Mixing

Thoroughly blend the two ingredients for 2 minutes - longer in cooler temperatures *(Figure 3)*. Scrape the sides and bottom of the pot when mixing. If using the mix for coating, after mixing, quickly pour into a roller pan to extend the open time.

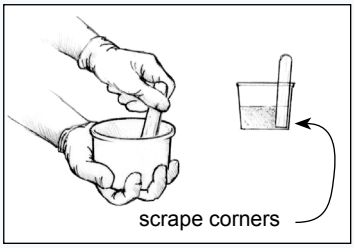


Figure 3 Stir resin and hardener thoroughly together for 2 minutes, longer in cooler temperatures.

WARNING! Curing epoxy generates heat. Do not fill or cast layers of epoxy thicker than 10 to 12mm – thinner if enclosed by foam or other insulating material. If left to stand for the full pot life in a plastic mixing cup, the mixed epoxy will generate enough heat to melt the plastic. If a pot of mixed epoxy begins to exotherm (heat up), quickly move it outdoors. Avoid breathing the fumes. Do not dispose of the mixture until the reaction is complete and the material has cooled.

2.5 Adding Fillers and Additives

Fillers

Throughout this booklet, reference to epoxy or resin/hardener mixes is defined as mixed resin and hardener without fillers added; thickened mixes or thickened epoxy will mean mixed resin and hardener with fillers added. Fillers are used to thicken epoxy for specific applications such as bonding or fairing.

After selecting an appropriate filler for the job in hand (selection guide - page 34), use it to thicken the epoxy to the desired consistency. The viscosity or thickness of a mix required for a specific job is controlled by the amount of filler added. There is no strict formula or measuring involved - visually judge the consistency which is best suited for the task in hand. *Figure 5* gives a general guide to the differences between unthickened epoxy and the three other consistencies referred to in this manual.

Always add fillers in a two-step process:

1. Mix the desired quantity of resin and hardener thoroughly before adding fillers. Begin with a small batch - allow room for the filler.

2. Blend in small quantities of the appropriate filler until the desired consistency is reached *(Figure 4)*. Ensure the filler is thoroughly blended before the mix is applied.

Figure 4 Stir in small quantities of filler until the desired consistency is reached.

For maximum strength, add only enough filler to completely bridge gaps between surfaces without sagging or running out of the joint or gap. A small amount should squeeze out of joints when clamped. When making fairing compounds, add as much 407 or 410 as can be blended in smoothly - for easy sanding, the thicker the viscosity, the better. Spread the mix into a thinner layer, either around the inside of the mixing cup or onto a flat non-porous surface or palette, to extend the working life.

CONSISTENCY	Unthickened	Slightly thickened	Moderately thickened	Maximum thickness
	"SYRUP"	"KETCHUP"	"MAYONNAISE"	"PEANUT BUTTER"
GENERAL APPEARANCE				
CHARACTERISTICS	Drips off vertical surfaces.	Sags down vertical surfaces.	Clings to vertical surfaces. Peaks fall over.	Clings to vertical surfaces. Peaks stand up.
USES	Coating, "wetting-out" before bonding, applying fibreglass, graphite and other fabrics.	Laminating/ bonding flat panels with large surface areas, injecting with syringe.	General bonding, filleting, hardware bonding.	Gap filling, filleting, fairing, bonding uneven surfaces.

Figure 5 Epoxy can be thickened to the ideal consistency needed for a particular job. The procedures in this manual refer to four common consistencies: syrup, ketchup, mayonnaise and peanut butter.

Additives

Although additives are blended with mixed epoxy in a similar two-step process, they are not designed to thicken the epoxy. Additives give the epoxy additional physical properties when used as a coating and pigments provide a colour base for future overcoating with quality marine paint. *Refer to the descriptions of the additives on page 45.*