Cold Temperature Bonding & Sealing

Epoxies can be made to be forgiving; however, we know that they must be used within certain latitudes of application, temperature, humidity, joint fit, surface preparation and cure times. Epoxies rely on an extremely complex chemical reaction to achieve their strength and longevity; and all of these variables can drastically affect, and in many cases compromise, the short and long term performance of epoxy resins.

Epoxy can be used under cold weather conditions, but must be used with particular adherence to application techniques. These procedures and considerations do not apply to WEST SYSTEM®epoxy alone; any epoxy used in critical marine or aircraft structural situations may have its capabilities and performance affected by cold weather problems.

Chemical Characteristics

When you mix an epoxy resin and hardener together, you start a chemical reaction which, as a by-product, produces heat. This is called an exothermic reaction. The ambient temperature in which an epoxy chemical reaction takes place impacts the rate of the reaction. Warmer temperatures accelerate the reaction, while cooler temperatures retard the reaction time. It is the duration of the reaction which, among other variables, will lead to complete or incomplete bonding of the epoxy molecules. If the reaction is too slow, even though the epoxy may be hard, it will not reach complete cure, and therefore never achieve its designed physical properties. Improperly cured epoxy may possess enough strength to hold the structure together, yet it may very well fail after being subjected to repeated loading during normal operations.

Working Properties

First, it is more difficult to mix the resin and hardener thoroughly: the resin flows through the dispensing pumps and out of containers with greater difficulty; the cold epoxy and hardener are prone to clinging to surfaces of the pumps, containers and mixing tools; and they resist being completely blended unless thorough mixing is employed. Remember, because of the low temperature, the chemical reaction is slower.

Second, the mixed epoxy is much harder to apply. Cold temperatures make epoxy stiff making it difficult to coat and wet-out surfaces with.

Third, air bubbles may be introduced when mixing and held in suspension due to the chilled epoxy's increased surface tension. This can be especially troublesome in clear-finish applications.

Cold Weather Techniques

Six basic cold weather rules to follow:

1. Use WEST SYSTEM® H205 Fast Hardener that has been formulated with a chemically activated polyamine system which exhibits a good cure as low as 2°C. It exhibits a faster cure characteristic than H206 Slow Hardener and offers less uncured exposure time, which reduces the chances of incomplete cure due to cold temperature.

2. Dispense in the proper mixing ratio of 5:1. Increasing the amount of hardener will not accelerate cure, but it will seriously compromise the epoxy's ultimate strength.

3. Pre-warm resin and hardener before using. As we discussed above, the warmer the resin and hardener, the lower the viscosity. The thinner resin and hardener will flow through mechanical pumps better, cling less to containers and mixing equipment, and exhibit superior handling and wet-out characteristics. The epoxy can be warmed using heat lamps or can simply be kept in a warm area until you are ready to use it.

4. Stir the resin and hardener thoroughly. Use extra care when mixing the resin and hardener, and mix for longer than normal periods of time. Scrape the sides and bottom of the mixing container, using a chisel-shaped mixing stick. Using a smaller diameter mixing pot will also improve the chemical activity because the limited surface area will not dissipate heat produced by the reaction.

5. Warm working surfaces. Applying warmed epoxy to a cold structure will quickly retard the molecular bonding activity of the epoxy. Be certain the structure, as well as the area surrounding the structure, is brought up to temperature. A hull, for example, which is colder than the surrounding air may experience condensation and result in water contamination to epoxy applied on it. Warm the structure as much as possible. This can be done by constructing tents around small areas, heating with portable heaters, warming the area with hot air guns, hair dryers or heat lamps. Small components or materials (such as fibreglass cloth) can be warmed before use.

6. Prepare surfaces carefully between applications. When coating under cold conditions, the thin film of epoxy often dissipates any exothermic heat generated by the reaction. Because heat is dissipated so quickly, the epoxy may not cure for an extended period of time. Carbonisation may occur, resulting in the formulation of an amine blush on the surface. Immediately prior to applying subsequent coatings, sand lightly and then wipe the surface area clean with a soft, damp, clean rag. Allow the surface to dry thoroughly.

7. Allow extra cure time before removing clamps or stressing joints. As a general rule, double the cure time for every 10°C drop in temperature. Allow even more time for pre-stressed joints and joints subject to high loads.

8. If possible, apply heat to speed up or complete the cure after the epoxy has reached a partial cure at room temperature. This process, called post cure, will help strengthen the bond and improve the epoxy's physical properties. Do not heat above 50°C.

Cold Weather Storage

It is best to store WEST SYSTEM® epoxy materials above 2°C with the container caps screwed down tightly. Materials which are stored in extreme cold may cause crystallization.

The formation of crystals does compromise the epoxy, and they can be remedied.

Boil water in a pot large enough to hold your epoxy containers. When the water boils, remove the pot from the heat source and carefully place the epoxy containers in the water. Do not allow the water to overflow into the epoxy containers.

Remove each container's lid to avoid pressure buildup which may cause the bottles to burst. Continually stir the epoxy with a clean stick until the liquid regains clarity and all crystals have melted. Remove from the water, replace the lids tightly and invert the container to melt any crystals which may be clinging to the top of the container.

If the resin pump has crystallized, pumping warm resin through it should dissolve the crystals.

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