The User Guide to Handling Solvent-Free Epoxies in Cold Conditions

SP SYSTEMS ADVANCED COMPOSITE MATERIALS

■ INTRODUCTION

This guide is intended for all users of epoxy products and designed to widen the temperature range under which the products can be used.

The type of epoxies most influenced by temperature levels in the workshop are the 'structural' epoxies which are used for boatbuilding and repair both with wood and frp, and general woodworking: **SP 110, SP 106, SP 320, Spabond 120** and **Handipack**. Unlike the two-part 'coating' epoxies, **Eposeal 300, Epocote 301** and **Hibuild 302**, the structural epoxies are all relatively viscous systems comprising a resin and hardener which react together chemically to form a rigid polymer thermoset plastic. Typically the structural epoxies are used in 4 main areas:

- In all high strength adhesive applications
- As laminating resins
- As a base to create fillers
- As coatings for a wide range of substrates.

To achieve the designed properties, all epoxies are very dependent on the user combining the resin and hardener components accurately in the correct ratio in order to obtain a complete chemical reaction during the curing process. For the systems mentioned above, certain temperature levels are also necessary during the curing process to ensure that the chemical reaction goes to completion.

■ THE EFFECT OF A LOW TEMPERATURE ENVIRONMENT

Each of the above-mentioned epoxy systems has been designed to be used in dry, warm conditions within the temperature range of 15° - 25°C. Under these ideal conditions they have good working and handling characteristics for their purpose and cure in a predictable manner to give reliable and good mechanical properties. With decreasing temperatures below 15°C, these epoxies become progressively thicker, which makes accurate dispensing difficult and effective mixing impossible. The reaction rate also falls with temperature and the slow cure may eventually impede the chemical reaction so that full properties are never achieved. This can be particularly the case with epoxies used as coatings.

Since many users are busiest throughout the winter months it is not surprising that the structural epoxy has developed a reputation for being demanding and difficult to use.

■ THE SP SOLUTION

At SP Systems we see no reason why boatbuilders and other users should not, with careful product selection, continue to use epoxies at temperatures as low as 5° - 10°C ambient. For many applications, if some basic rules designed to initiate the chemical activity of the mix are observed, successful work can be carried out. These rules are as follows:

1. Keep the resin and hardener components warm, eg: by placing containers near to a workshop heater if possible (avoid hot surfaces and naked flames). If a heater is not available, then immerse the sealed containers in a bucket of hot water until the viscosity is sufficiently low to allow easy dispensing.

2. After dispensing the components into a mixing cup, mix the resin and hardener very thoroughly for at least 1 minute. If possible direct a warm air source directly at the underneath of the container whilst mixing. The resulting reduction in viscosity will ensure that the two components are mixed intimately to give a more thorough cure and ensure that the mix contains the minimum of trapped air bubbles.

3. If possible arrange for the work area to be enclosed within a small area 'tent' using polythene sheeting so that the temperature within the work area may be raised to acceptable levels.

If a power source is available, then numerous jobs can be carried out quite successfully at temperatures of less than 15°C using an electric hot air gun to provide a local intense heat source.

■ SPECIFIC RECOMMENDATIONS TO BE APPLIED WHEN GLUEING AND COATING WOOD

Glueing

To achieve the strongest bonds when glueing, it is essential to apply the epoxy adhesive mix onto both surfaces. Since these surfaces may be cold a hot stream of air from a hair drier or hot air gun directed onto the wetted surfaces will greatly aid penetration of the glue into the wood fibres. Once the wood parts have been brought together and the glue joint enclosed, the epoxy will be relatively insensitive to the possible detrimental effects of both high levels of atmospheric moisture (high RH) and low temperature.

For any **SP** resin system that has a choice of hardener speeds, it will turn semi-solid(gel) after an overnight cure even at temperatures of 0-5°C using the **Fast** hardener option. It may still be sufficiently soft to be marked by a thumb nail but hard enough to enable the removal of holding screws. Some epoxies used as adhesives are intrinsically better at curing at low temperatures than others. **SP Speedipack** is one which is designed to cure well at low temperatures and will develop the minimum of surface by-product when used as a coating.

An effective way to accelerate the cure of the bond is to spend several minutes with a hot air-gun gently warming the bonded area. Even if the bond experiences freezing conditions afterwards the reaction will have received sufficient acceleration to cure hard within 12 hours.

Coating

In coating applications the correct temperature level is of even greater importance than when epoxies are used for bonding. Data sheets for the product will often give temperature limits below which coating should not be attempted. This temperature is usually around 15°C, but the ideal temperature for coating is in the region of 20° - 25°C. At this temperature range, solvent-free epoxies show good penetration into the surface wood fibres and good flow characteristics which allows easy application by brush or roller. If the temperature is allowed to fall the application is particularly difficult and in a thin film state, the cure will be long and result in a poor quality finish, often accompanied by excessive surface by-product.

We have found that the way to good coating performance from products such as **SP320** (which is particularly sensitive to low temperatures), is to use an electric hot air gun both during and after application, as follows:

- Before commencing coating, pre-warm the specific area to be coated, using a hot air gun. On wooden surfaces, this will also eliminate any traces of moisture in the surface wood fibres.
- When brushing out the product, direct the nozzle of the hot air gun at the surface of the wood on which the epoxy is lying and at the same time brush the product onto the surface in the normal way. Strong localised heat from the gun has a quite dramatic effect in the following ways:

    1. The viscosity of the resin is reduced to such an extent that it penetrates deep into the wood fibres and moves easily into small fissures or splits.
    2. The heat also causes air to be expelled from the wood and the spaces vacated will be filled by resin. The viscosity of the resin will also be sufficiently low to allow any air released from the wood to break freely at the resin surface.
    3. Air will also be expelled from within the coating film, resulting in higher properties such as greater moisture resistance and a significantly enhanced level of clarity.
    4. Heating at this stage has the effect of accelerating the initial cure to such an extent that by-product formation can often be completely avoided even though the coating is subsequently left to cure at a low temperature.

The Importance of Controlled Heat Application

The amount of heat which should be used in these instances should only be sufficient to give the desired viscosity without resulting in a local exotherm. This is where the internal heat generated by the epoxy cure accelerates the chemical reaction resulting in a 'thermal runaway'. Warning of exotherm is given by the emission of white fumes and a concentration of many small air-bubbles within the coating. If caught quickly at their onset, these bubbles can be brushed out before they become a permanent feature.

Obviously the longer that heat can be applied, the more quickly the surface film will harden and cure. The minimum treatment at 10°C is that for every 1 sqm, heat should be applied evenly over the surface for approximately one minute.

With this treatment, the coating should become tacky in approximately 30 minutes at 10°C. However, it would be wise not to sand the surface until 24 hours has elapsed, after which it may be sanded with 80 grit production paper.

Additional coats can be applied, also with the aid of a hot air gun, but sufficient heat should be used only to aid resin flow in order to achieve an even coverage.

Both **SP106** and particularly **SP320** will respond well to this treatment and coatings of exceptional clarity and uniform thickness can be achieved.

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