c/o Endurance Technologies
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Glassing with Knitted Reinforcing Materials

Handling the latest generation of knitted reinforcing materials can be both rewarding and challenging. Knitted reinforcements (as opposed to woven rovings and cloth) come in a variety of weights (usually described in ounces per square yard), fiber orientations, and with various backings stitched onto the reinforcing fibers with bias yarns.

Unidirectional, biaxial, triaxial and Quadraxial are simply words used to express the number of layered fiber bundles. Orientations of the fiber bundles whether it is fiberglass, carbon, or aramid are described in the number of degrees off axis (the axis is the production direction). For instance, a unidirectional material will have one layer of oriented fiber bundles in one direction held in place by bias yarns, a biaxial knit will have two layers of oriented fibers, and so on. Quite often people will refer to a biaxial fabric by its fiber weight and orientation.

Builder 1: "I glassed the outer layer in a 12 oz +-45 degree biax."

Builder 2: "Yeah, I like the way the biax drapes more than the 18oz triax; the additional axial fibers (0 degree) seemed to make the stuff handle like wet cardboard."

Builder 1: "Have you ever tried putting the axial fibers as a uni over the biax in a second step almost like making your own triax without the conformability issues."

All this is quite a mouthful and fiberglass technicians who are in the stuff every day become intimately familiar with issues surrounding wet out, drain out, conformability, print, itching and a whole host of other parameters surrounding the selection and application of one knitted reinforcement over another. In this article we will only touch lightly on each of these subjects, as each subject is worthy of a book.

Once the fiber orientation necessary for the job has been decided there begins the issue of weather the knit should include a backing material or not. Knitted reinforcements may include a vail or mat (chopped strand) backing. Chopped strand or mat backing is the most common and provides additional interlaminar adhesion. In plane language this means that the backing works as a conforming pillow of randomly oriented fibers between one layer of knit and the next. When using backed knits the backing should always rest on the substrate or down side. When using backed knits in-mold the backing should always face the mold surface. In-mold laminating brings us to another area where backing can be advantageous. Once a mold has been prepared for laminating, backing or the above mentioned pillow will reduce print-through sometimes associated with knitted reinforcements. The greater the amount of pillow or backing the less likely the oriented knitted reinforcement will show through. There are other reasons for print-through however we will not go into that right now. Chopped strand and vail backings should be binderless for optimum performance when used with epoxy resins. Binder is used to hold chopped strand mat together. The binding adhesive is broken down by styrene monomer associated with polyester and vinylester resins allowing the mat to conform easily. MAS Epoxies on the other hand, contains no monomer or solvents capable of breaking down binders, so backing containing binders should be avoided.

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End users can confirm with the manufacturer as to a presence or lack of binder in the backing material. Most major suppliers of knitted reinforcements are providing binderless chopped strand backed knits. The chopped strand backing is held in place by the bias yarns. So what is the down side to backing? Backing represents additional glass (weight) with out the oriented strength associated with the reinforcing fiber bundles of the knit. Backing adds an additional layer within the knit which must be wet-out and lastly backing retards the ability of the knit to shear which effects the overall conformability and draping qualities of the knit.

WETTING OUT

Wetting out of heavy (over 17oz. per sq. yard) multi-axial knits can be challenging. When working with the really big stuff (over 34oz. per sq. yard) use of bristly rollers, short spike metal rollers and bubble blisters may be necessary to ensure thoroughly wet, low void content laminates. Unlike woven reinforcements, knits have little to no fiber crimp. Fiber crimp retains resin and resists resin drain-out. The low viscosity required to wet-out the multi-layered knits is also prone to drain-out. Drain our may result in epoxy sitting in a pool at the bottom of the mold or on the floor (not a good place for expensive epoxy laminating resin). To avoid drain-out issues thixotropic fillers may be added to the resin mix prior to wetting out. Thixotropes increase a resin's resistance to sag or drain. Cab-O-Sil or Degussa=s Sipernat D15 are very effective Thixotropes and may be added up to 50% by volume to the resin mix without greatly effecting the wetability of the total system.

In other words the resin will wet into the knit and then resists draining until it is cured. We have spent a little bit of time looking at the loading ratio of thixotropic fillers. The following represents a guideline used by one of our customers who uses quite a bit of knitted reinforcements.

If the reinforcing material is in the 17-50 ounce range it is recommend to add 25-50% by volume Cab-O-Sil, or D15 to the resin mix by volume. This is just a starting point every fiberglass technician forms a sliding scale of filler quantity verses knit weight. For example: the above formula may be perfect for 40oz. knitted reinforcements however a finer knit (12oz/sq. yard) may require no Cab-O-Sil at all.

Wetting-out anything over a biax (i.e., a tri or quad) can be quite challenging. Patience is the name of the game. We have gone through the trouble of modifying the surface tension and viscosity of MAS resins to maximize wetting and release air. However, once the resin is in contact with the fibers it must be allowed a little time (just a few minutes) to wet through. The best way to spend this time to continue applying resin to the remaining area. We have wetted through multi-axial knits up to 50 ounces per square yard from one side, so be patient. Once wet, bubbles may have to be chased and excess resin squeeged into dry areas.