



Prepreg Winding Delivery Systems



August 2007

Introduction

- ◆ Prepreg tow, roving, yarn, etc., is fiber with the matrix resin impregnated into it before it is placed on the winding machine
- ◆ It generally requires refrigeration to impede premature staging or curing
- ◆ Because the resin is already on the fiber, the system is clean, fast, and uniform
- ◆ TCR™ prepreg has one very big advantage: ***NO refrigeration***

Prepreg Delivery System

- ◆ **The delivery system that makes preregs run smoothly is slightly different from a wet winding system**
 - » **Must have higher fiber tension than most wet winding (at the spool and the part)**
 - » **Requires rollers for the complete fiber path**
 - » **Should have a swiveling, or castoring, delivery head**
 - » **Does not require dust particle or fume extraction system**

Prepreg Delivery System Specifications

- ◆ **Specifications for the delivery system used for winding prepreg should include:**
 - » **Tensioners**
 - » **Rollers**
 - » **Delivery head**
 - » **Facilities requirements (creel box, ventilation/pressurization, freezer, etc.)**

Tensioners

- ◆ **Fiber take-up capability to keep tension on the spools and part at all times**

- ◆ **Every direction change has the possibility of detensioning the fiber. If this occurs the fiber could...**
 - » **Wrinkle and break or weaken**
 - » **Become misaligned, creating a gap or lap**
 - » **Become loose and not nest properly**

- ◆ **We recommend rewind tensioners. Good examples are: Entec CAT II, Helman HE-2002A, and McClean Anderson D-1. CTC mechanical tensioners with dancer bar take-up will also work. Tensioners should have the capability of 10 lb tension for use with up to 18K carbon fiber and up to 20 lb tension if used for 24-50K fiber**

Tensioners (cont)

- ◆ **Tension should be maintained at 5-10 lb with 12-18K tow material (>10 lb with 24-50K) to ensure proper fiber nesting and good fiber unspool**
 - » **For optimal performance, pressure vessels should be wound using ~10 lb tension per tow when using 12-18k carbon fiber towpreg**
- ◆ **Tensioners may be housed in a cabinet that is remote or one that travels with the delivery head**
- ◆ **With the correct roller setup, the cabinet may be positioned off the machine, but very close**
 - » **There is no need for long distance, space-wasting, remote tensioner cabinets**

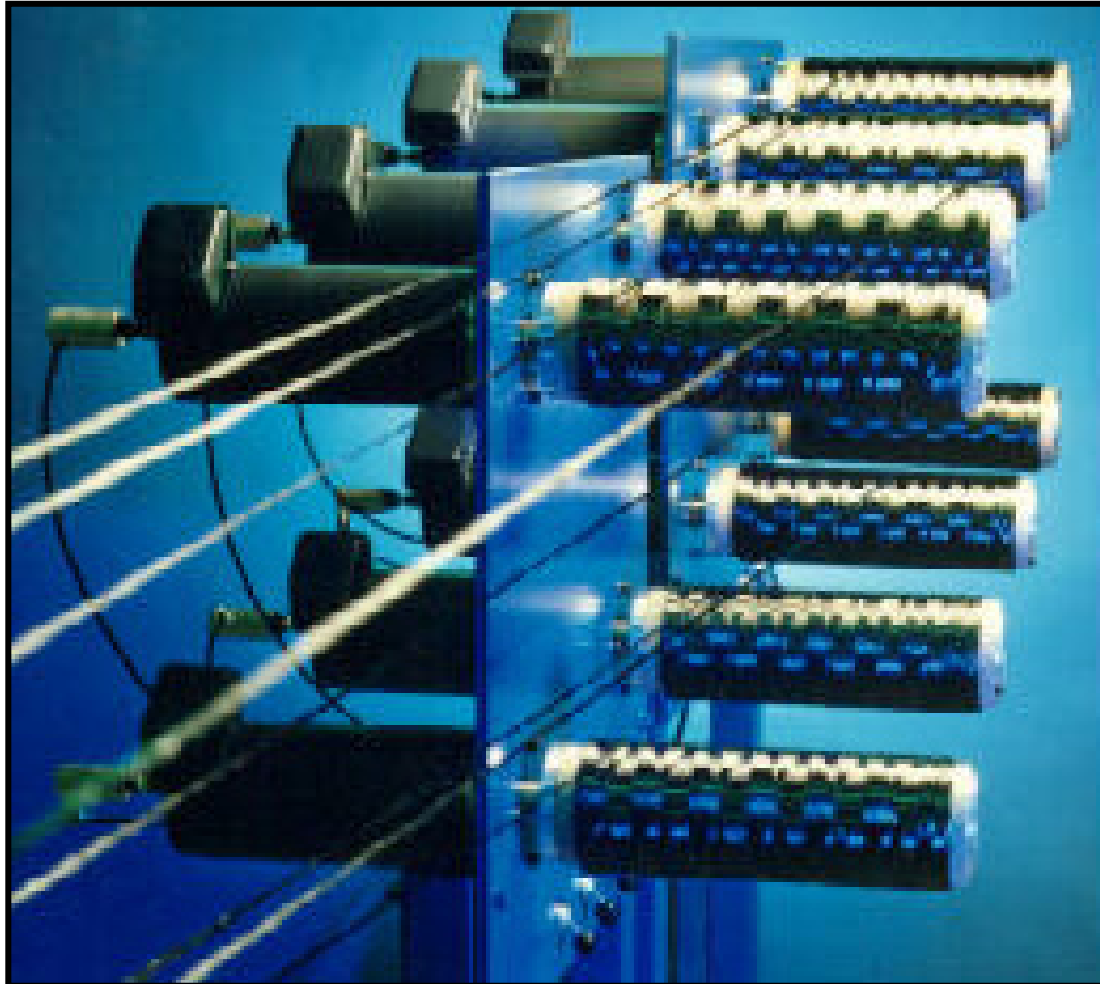
Entec Dancer Bar Take-Up Tensioners



Tensioners (cont)

- ◆ **The ability to constantly control tension over the complete path of the fiber is one of *THE MOST IMPORTANT KEYS* to repeatable quality products!**

Helman 2002A Rewind Tensioners

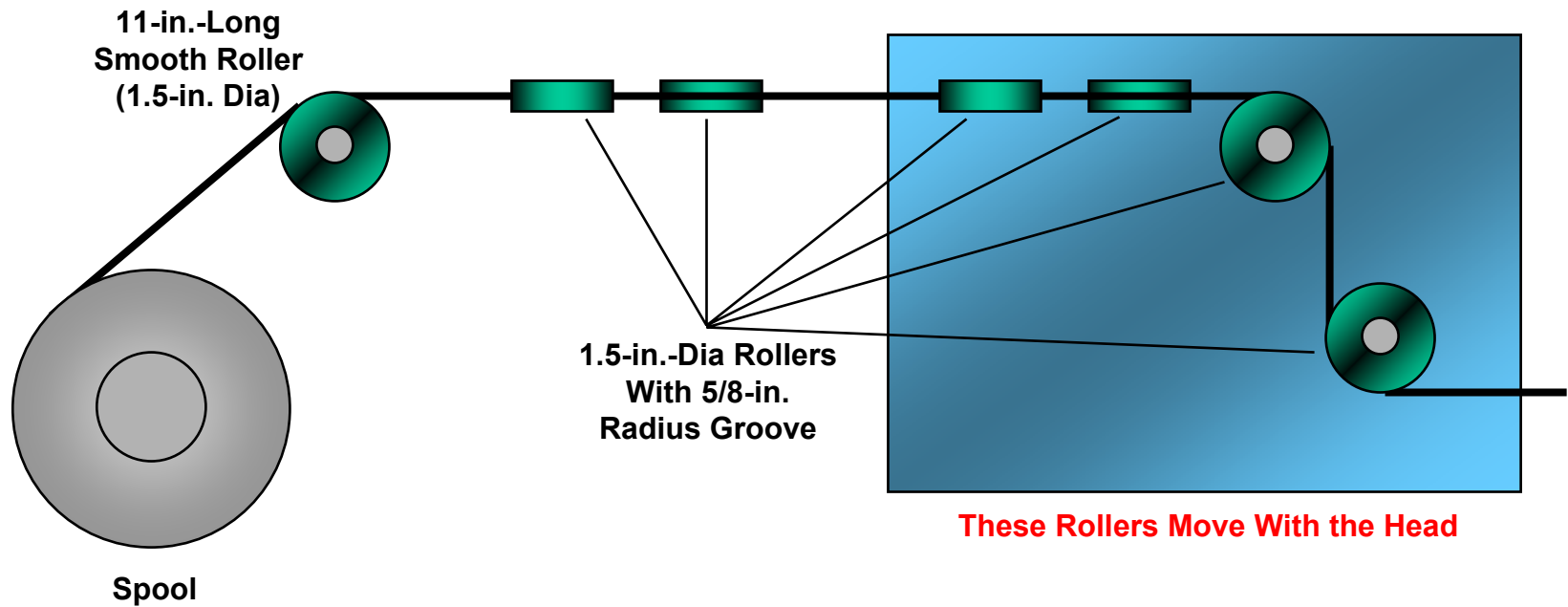


Rollers

- ◆ Individual rollers for each fiber path
- ◆ Must take the fiber all the way to the final delivery roller where they may come together on one smooth roller or go directly onto the part
- ◆ The fiber should have a straight path from roller to roller in order to keep the ribbon flat. Using shoulders on the roller edges for direction change will fold and twist the fiber
- ◆ Horizontal-to-vertical, etc., fiber path changes should be on the same plane so that the entire width of the fiber travels the same distance at equal tension

Rollers (cont)

DELIVERY SYSTEM USING A FIXED CREEL AND REWIND OR TAKE-UP TENSIONERS

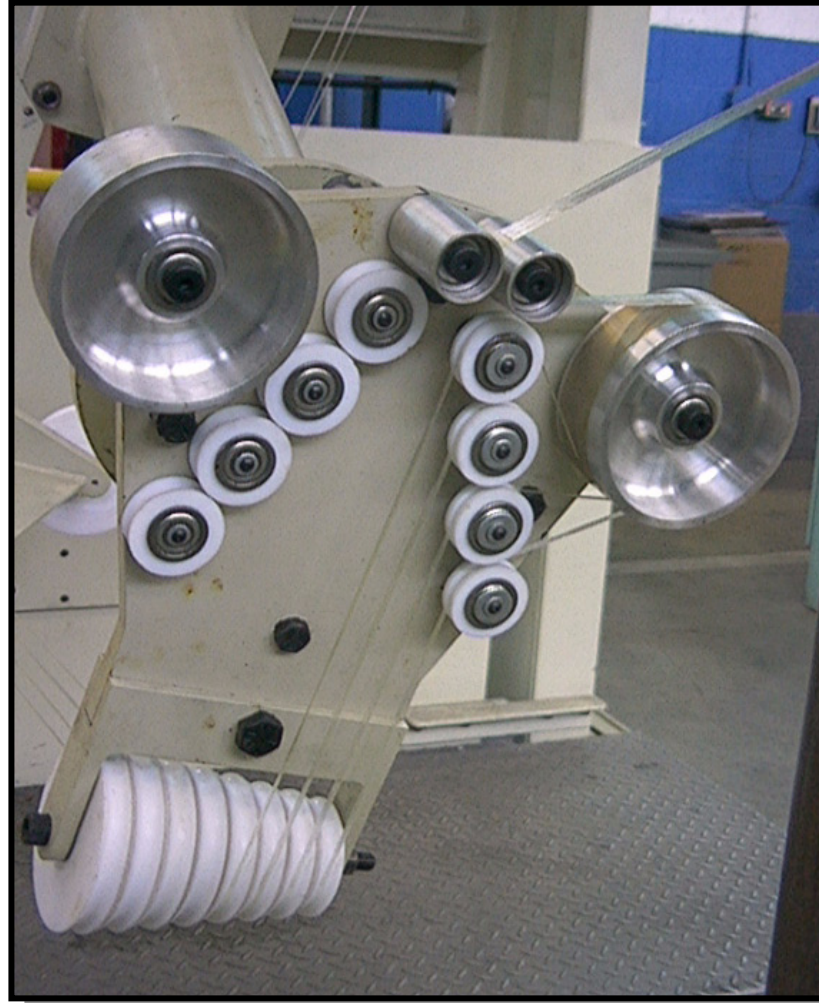


Rollers (cont)

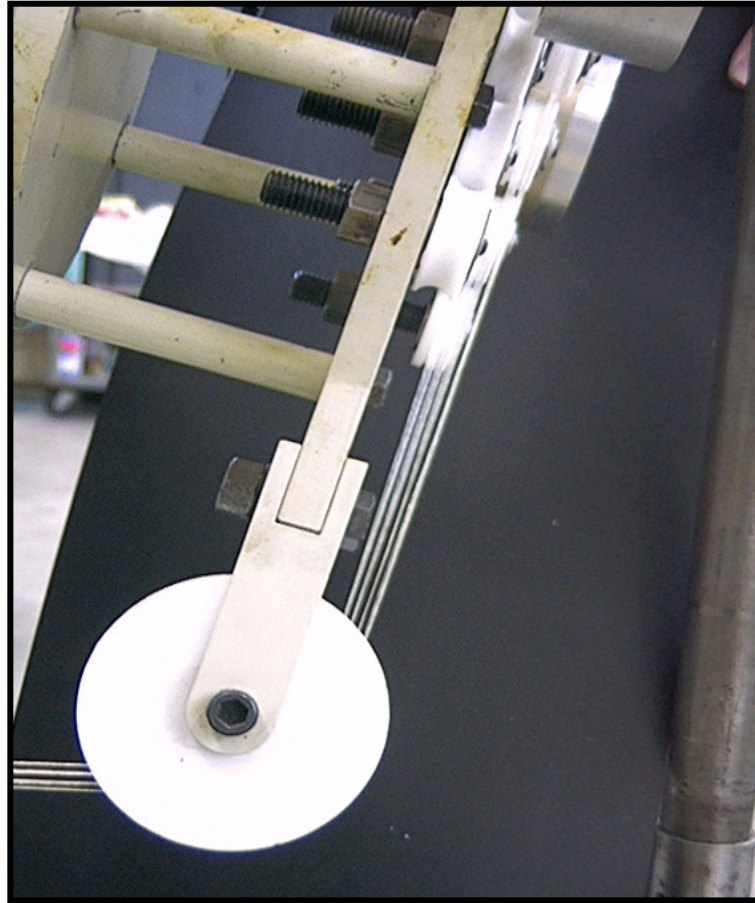
- ◆ **Rollers should be made from non-stick materials**
 - » **Teflon, glass-filled Teflon (more durable than Teflon), Teflon-coated aluminum or Teflon-coated steel, etc. (uncoated stainless steel or aluminum will also work, but not as well)**

- ◆ **Rollers should have bearings**
 - » **Ball or roller bearings work best**
 - » **Bushings will also work, but may wear out faster**

Teflon and Aluminum Rollers on Polar Winding Machine



Fiber Transferred From Christmas Tree Rollers to Adjustable Rollers

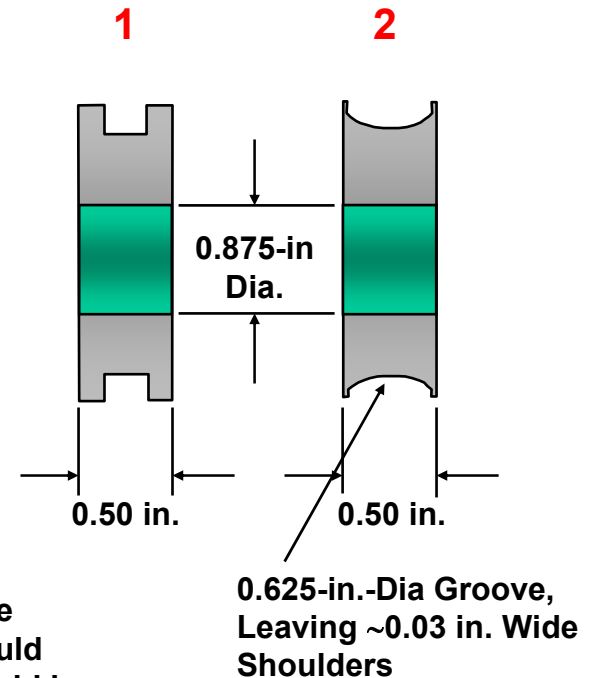
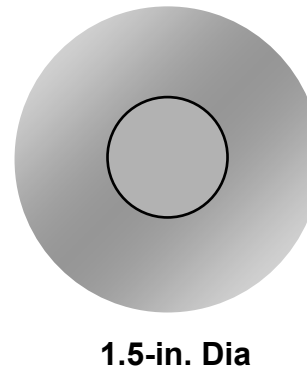


Rollers (cont)

TYPICAL ROLLERS

Rollers fabricated from Teflon or glass-filled Teflon

- **Roller No. 1**
 - 1.5-in.-diameter shoulder
 - 1.25-in. diameter at bottom of groove
 - Width of roller: 0.50 in.
 - Width of groove: 0.125 in.
 - Standard bearing: 0.875-in. diameter
- **Roller No. 2**
 - 1.5-in.-diameter shoulder
 - 1.25-in.-diameter at bottom of groove
 - Width of roller: 0.50 in.
 - Width of groove: See sketch
 - Standard bearing: 0.875-in. diameter



Two typical rollers (1) and (2) for fiber delivery. 1 is sometimes used in the delivery head for final fiber alignment. For this use, the groove width should match the fiber bandwidth. If used before the head, the groove width should be slightly wider than the fiber bandwidth. Roller 2 is a “universal” roller that can be used anywhere before the final delivery head and should work for any fiber bandwidth up to ~ 0.375 in. wide

These take two (2) flanged bearings each with an inside diameter to match the Teflon. The diameter is not important. It is just what we chose to use for all our bearings so that we would not have to stock several sizes

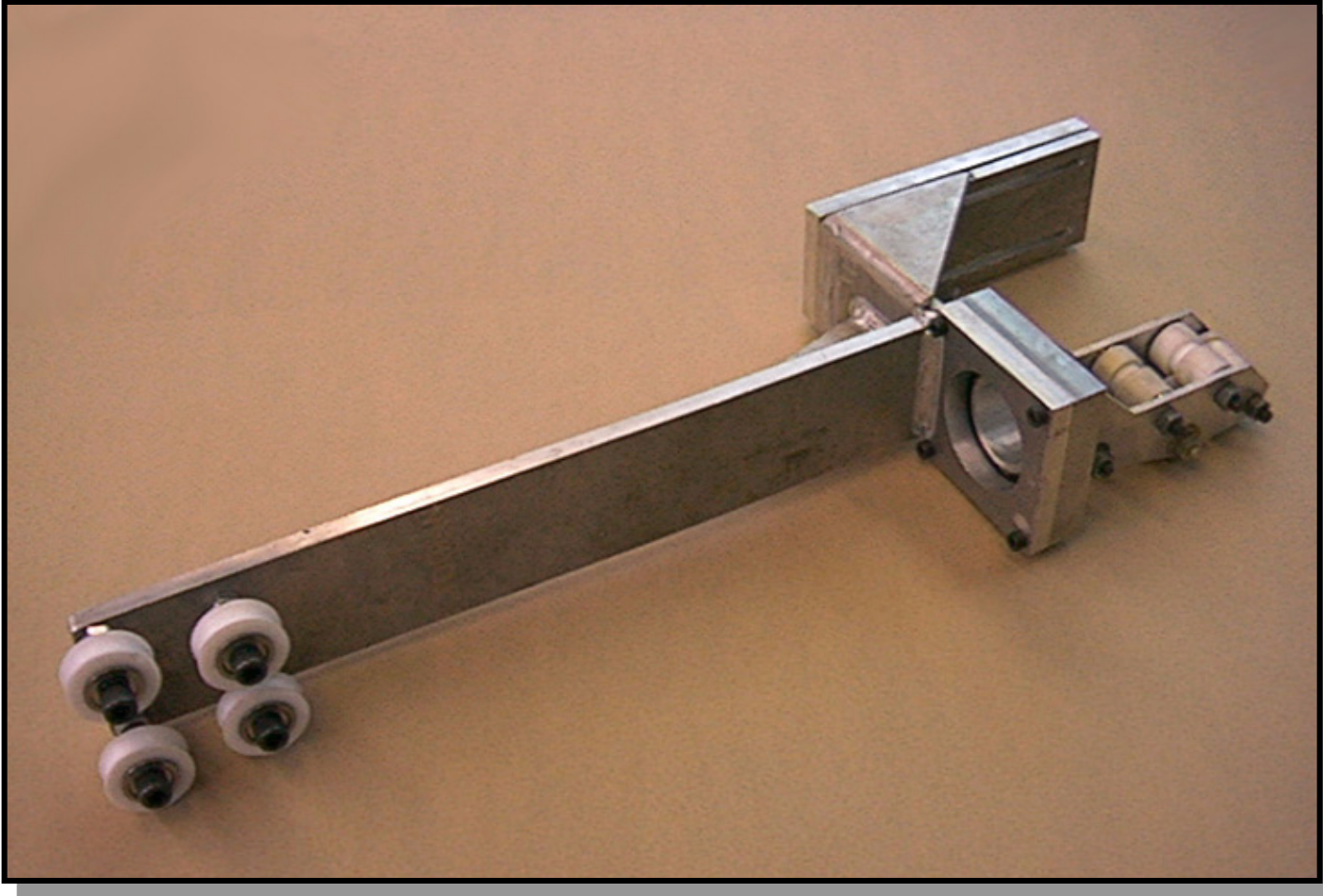
Delivery Head

- ◆ It should be either powered or free-castoring
- ◆ The fiber will make a constant twist when going from horizontal to vertical, etc., but ***FIBER DIRECTION CHANGES SHOULD BE ACCOMPLISHED BY MOVING IN AND OUT OF A ROLLER OR SET OF “S” ROLLERS ON THE SAME PLANE***
- ◆ Fiber (multiple tows) may be combined at the last roller or on the mandrel itself

Powered Head on EnTec Winding Machine



Simple Castoring Winding Head



Facilities Requirements

- ◆ **Fume and particle ventilation are *NOT* necessary**
 - » **During wet winding, carbon particle control can be a big problem for electronics, as well as adversely affecting personal health and comfort**
 - › **In prepreg winding, carbon particles are trapped in the resin matrix and are not free to contaminate the air**
 - » **For health and environmental reasons, solvent and fumes can also be a big problem when wet winding**

Facilities Requirements (cont)

- ◆ Refrigerated storage **NOT** necessary for TCR™ products
 - » The long shelf life with no refrigeration makes starting and stopping very easy because the spools can stay on the machine until they are used up
 - » Shipping and storage is also greatly simplified, with much lower cost in both cases
- ◆ Very little solvent is necessary for cleanup when using preregs

Summary

- ◆ **Prepreg winding is very easy if these basic rules are followed:**
 - » **Tensioners with take-up capability are used**
 - » **Tension is > 5 lb minimum**
 - » **Rollers are used throughout**
 - » **Fiber path is carefully aligned**
 - » **Castoring or powered head is used**
 - » **UseTCR™ preregs**

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