

Prepreg vs. Wet Wind Comparison



- Controlled Resin Content
- Helical Winding Patterns
- Pot Life Considerations
- Reliable and Consistent Cylinder Performance
- Toxic Materials Considerations
- Quality Control
- Wet Winding
- Advantages of TCRTM Prepregs
- Considerations
- Summary
- Question and Answers

Prepregs

- Resin Content (RC) % can be specified by customer
- RC can be controlled to $\pm 2\%$
- Resin content is verified by measuring the weight of tow lengths received from suppliers
- All cylinders on multi-spindle winder receive essentially the same resin content
- Results in consistent part weights

Wet Winding

- Operators must adjust “doctor blade” on resin bath
- Use visual inspections during winding process
- Consistent resin content is difficult to maintain with many spindles and large resin baths
- Cylinders on different spindles often have different resin contents
- Results in part weight variation

Prepregs

- Towpreg tack or stickiness helps prevent fiber slippage
- Helps to eliminate gaps or laps between fibers
- Allows fiber path to remain very close to engineering design

Wet Winding

- Epoxy acts as a lubricant
- Can cause fiber slippage
- May allow fiber to move from engineer's original designed path
- Small changes in liner dimensions can cause major problems with fiber slippage



Prepregs

- TCRTM prepreg has a “pot life” of from 3 months to 1 year at room temperature
- Retesting of towpregs is essentially not necessary
- Little or no wasted materials
 - Estimated <5% by users

Wet Winding

- Wet wind resin generally has pot life of 6 to 8 hours
- Excess resin must be cured and discarded at the end of each day
- As winding facility temperature changes during the day, resin viscosity also changes
- Winter vs. summer blends etc.

Prepregs

- Burst strengths and pressure cycle testing much more consistent
- Coefficient of Variation (CV) controlled to 2.0% to 3.0%
- Allows for lower pressure design parameters

Wet Winding

- Difficult to produce consistent burst tests and pressure cycles
- Higher CV means more fiber required per cylinder
 - Users state CV between 7-10%

Prepregs

- TCRTM prepregs have no Volatile Organic Compounds (VOCs)
- Low fumes or emissions
- No solvents introduced into the process
- TCRTM prepregs *are not* solvent-based systems
- Low risk for any potential health hazards

Wet Winding

- Workers must take care and precautions to keep liquid epoxy from their skin
- Good ventilation is required in all work locations
- Many gallons or liters of liquid solvents may be used each day for cleanup
- Solvents must be disposed of by proper means
- Open resin bath = smell into the air

Prepregs

- Beginning with fiber manufacturing, materials are checked for lot-to-lot consistency
- Fiber impregnation is done in highly controlled environment
 - Temperature and humidity are controlled
- QC testing and records done by the “prepregger”
- Certificate of Conformance supplied for all fiber lots

Wet Winding

- Far more difficult to control
- Each batch of resin mix must be checked
- Resin content must be verified during or after filament winding
- Daily records must be kept on each resin component and mix batch
- Operator weigh-up techniques may vary greatly

Advantages

- Low initial raw material cost
- Simple raw material storage: cold box not generally required
- Allows flexibility in fiber / resin combinations

Disadvantages

- Requires resin mixing on-site
- Requires resin baths
- Resin pot-life issues
- Odors and off-gassing
- Solvents needed for cleanup
- Material waste
- Possible health hazards
- Health checks for technicians
- Less desirable environment for workers
- Facility becomes coated with resin from spills and operations

1. Very clean environment for workers
2. Higher throughputs per machine/per shift
3. Higher winding speeds
4. More time winding and less time cleaning up
5. Highly controlled uniform materials
6. No need to dispose of any chemicals from clean up
7. No excess resins to dis-guard
8. Resin and fiber lots easy to trace for record keeping
9. No rotation necessary for most applications because excess resin bleed can be controlled
10. Less shipping costs with prepreg (single purchase of goods)
11. Less human involvement with prepreg and less chance for mistakes
12. Easier to control lead time on prepreg material, about 4-weeks from order to receipt

13. Higher burst strengths and pressure cycle lives

- a) Fibers share pressure load better
- b) Fibers and resins have very good match, many years of verified performance with customers throughout the world
- c) Achieves higher burst strengths with better fiber translation
- d) Results in higher pressure cycle lives
- e) Predicted 15% less materials used vs. wet winding

14. More consistent burst strengths and pressure cycle life

- a) Consistency allows designers several advantages:
 - a) Design with less materials
 - a) Possible lower cylinder weights
 - b) Cylinder performance more predictable
 - c) Lower coefficient of variation from towpregs
 - d) Fewer lot test failures
 - e) Better fiber / resin lot-to-lot consistency

- **Financial parameters**

- Less downtime for cleanup
- Higher throughput (units per hour)
- Lower labor requirements
- Lower scrap rate / wasted materials (up to 15% reduction in scrapped materials), (resins)

- **Performance parameters**

- Better structural performance
- Better quality control
- Less variability

- **Environmental issues**

- No known carcinogens or high toxic chemicals in the resin
- Reduced use and disposal of solvents for cleanup



TCR Composite Products

- TCR Towpreg products are designed to maximize fiber translations for Composite Overwrapped Pressure Vessel (COPV) applications
- TCR Composites has developed, and is marketing, a unique high-performance prepreg system
- Storable at ambient temperatures
- Provides an environmentally friendly alternative to wet-resin application
- Available in a wide variety of tow, braid, and woven fabrics
- Resin system tailorable to suit various process requirements
- Cost-competitive pricing
- Questions?



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