VACUUM DEBULKING OF 3D FABRICS

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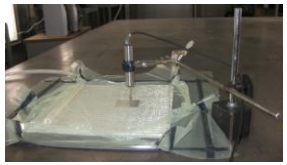
PROJECT OBJECTIVES

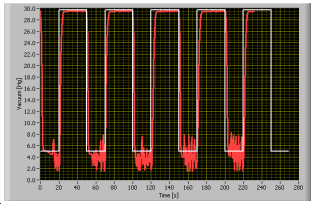
- Measure change in preform thickness due to cyclic compression using Smartmolding System.
- Vacuum debulking used to compact dry preform prior to infusion during VARTM process.
- Evaluate the effect the debulking cycle has on FVF for different fabrics and fabric architectures.
- What effect does higher FVF have on penetration resistance of the composite?
- Experiments were repeated with 54 and 96 oz. E-Glass, and 211 oz. S-Glass 3D weaves.

EXPERIMENT SETUP



- Preform Characteristics:
  - Fiber: 54 oz. E-Glass
  - # of Plies: 4
  - Size: 1' x 1' square
- Displacement measured with Linear Variable Displacement Transducer (LVDT), Smartmolding System, and LabVIEW software.

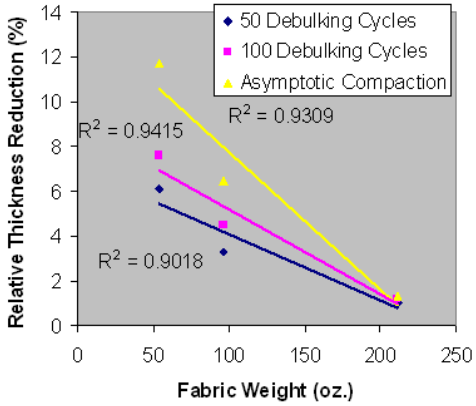
Debulking Cycle



- -5" Hg low vacuum level
- 20 second low vacuum dwell time
- -30" Hg high vacuum level
- 30 second high vacuum dwell time
- Cycle runs until preform compaction reaches asymptotic steady-state

RESULTS

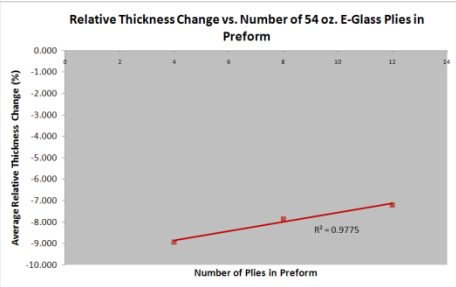
Relative Thickness Reduction vs. Fabric Weight for 4 Plies of Fabric



Effect of Fabric Thickness

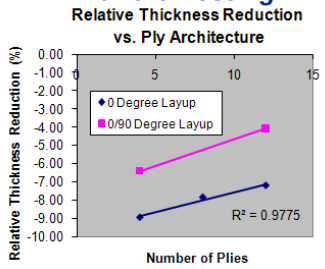
- The level of preform compaction is primarily a function of fabric thickness, the number of plies in the preform, and ply architecture.
- Thicker fabrics will compact less during the debulking cycle
- At asymptotic preform compaction:
  - 54 oz. E-Glass sees a 5% to 12% relative decrease in thickness
  - 96 oz. E-Glass sees a 2% to 5% relative decrease in thickness
  - 211 oz. S-Glass sees a 1% to 2% relative decrease in thickness

Number of Plies in Preform



- Relative preform compaction is reduced as the number of fabric plies is increased

Effect of Ply Architecture on Tow Bundle Nesting



- 0º ply architecture (all fabric plies oriented in same direction) allows for optimal tow nesting, and therefore maximum preform thickness reduction.

FUTURE EXPERIMENTS

- Resin infusion of preform after debulking cycle to see springback effects
- The effects that higher fiber volume fraction has on the mechanical properties; specifically penetration resistance of the composite to be examined.

ACKNOWLEDGEMENTS

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