DEVELOPMENT OF A COMPUTER CONTROLLED FLOW INJECTION SYSTEM FOR VACUUM INFUSION PROCESSES

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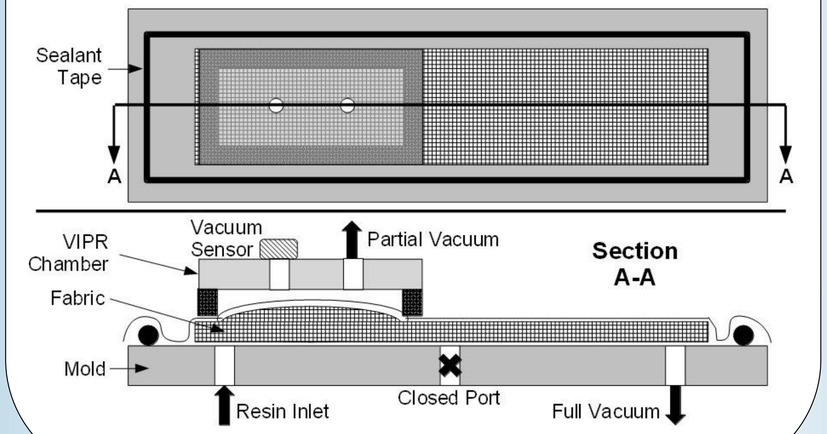
INTRODUCTION

- Liquid Composite Molding (LCM) is used to create large scale structures with significantly lower capital cost compared to autoclave processing.
- Resin must be driven into the mold to saturate the fibers. Failed infusions result in problematic flows such as:
  - Race-tracking
  - Permeability variation due to mishandling of the fabric.
- Control techniques for RTM have been successfully demonstrated with port injection. We'd like to establish the same automation capability for vacuum infusion.
- Vacuum Induced Preform Relaxation (VIPR) process shows potential for manipulating resin flow patterns in a controlled and automated setting.

THE VIPR PROCESS

- The VIPR process uses an external vacuum chamber to relax a local area of fabric.
- Resin flows in this area easier than other areas thus with this process we can manipulate flow patterns.



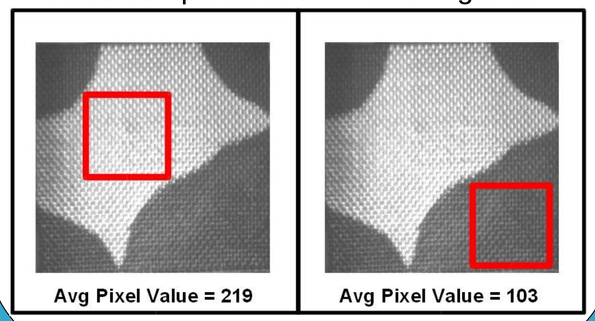
VIPR WORKSTATION

- A computer controlled gantry positioning system to automate the deployment of the VIPR Chamber.

Key Elements
- Motion Controller
- Stepper Motors
- Gantry System
- Linear Actuators
- Pneumatically controlled injection and chamber deployment
- Computer controlled systems

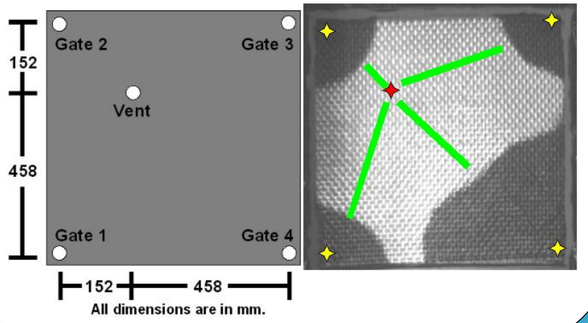
CAMERA RESIN DETECTION

- A digital camera is used to detect resin flow fronts.
- 8-bit Images are recorded, and dry regions have a clear difference in pixel value compared to saturated regions.



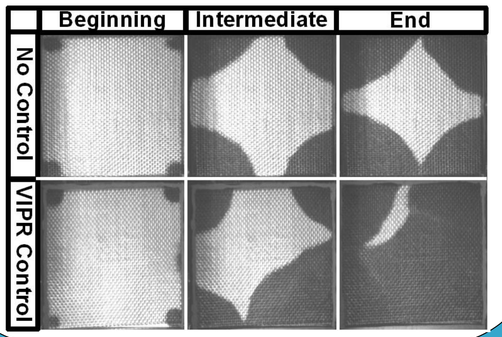
AUTOMATED MOLD SETUP

- Mold has four gates and one vent which are open during the entire infusion
- At time intervals the chamber is placed above the gate where the distance from flow front and vent is the greatest.



FLOW TESTING RESULTS

- Photos compare flow fronts from this mold with No Control and VIPR Control
- At end of the infusion: No Control shows 32.9% dry preform remaining while using VIPR control reduces this to only 5.3%.



CONCLUSIONS

- Gantry based Automated VIPR deployment developed and tested
- Simple automation was demonstrated
- Automated infusion can reduce void size and wasted resin during bleeding process.

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