COMPARISON OF DIFFERENT DISTRIBUTION MEDIA WITH VARTM PROCESS ON THE FLOW VISUALIZATION WORKSTATION

G. Denis (Intern) and S. G. Advani

University of Delaware • Center for Composite Materials • Department of Materials Science and Engineering

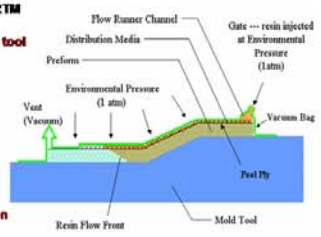
Motivation

- To improve the flow visualization workstation
  - In order to monitor the flow front easily from the top layer and bottom layer composite
- To compare different distribution media
  - To quantify the filling time and the resin used
  - To compare the flow behavior of the resin

VARTM Process (Vacuum Assisted Resin Transfer Molding)

Different steps during VARTM

- Preparation of the mold tool
  - Acetone
  - Frekote
- Preform cutting
- Preform stacking
- Peel ply
- Distribution media
- Vacuum compaction
- Impregnation by infusion
- Demolding



Flow Visualization Workstation

Two cameras (1) (1')

-To check the flow front on the top and bottom of composites

An electronic scale (2)

-To know the quantity of resin used during experiments

Acknowledgements

This work is supported by the Office of Naval Research through the Advanced Materials Intelligent Processing Center program.

Different Distribution Media

Used on the top of preforms

Black Distribution Media
Media
Fabrics

Used in the middle of preforms

- ***Lantor Soric XF***
  - Core material: polyester
  - Dry and infused thickness: 2 mm
  - Probably increase mechanical properties

- ***Colbond 7004***
  - Core material: Nylon 6
  - Dry and infused thickness: 4 mm

- ***Colbond 7005***
  - Core material: Nylon 6
  - Dry thickness: 6.3 mm
  - Infused thickness:1.5 mm

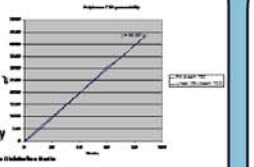
- ***Polybeam 730***
  - Core material: Polyester
  - Dry thickness: 9.9 mm
  - Infused thickness: 2 mm
  - Probably increase mechanical properties

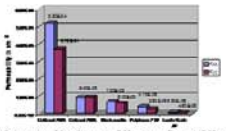
Permeability values

Obtained with Darcy's Law

$$X^2 = 2\,\frac{Kxx\,P}{(1-Vf)\,V}\,t$$

X^2: distance in cm^2
P: pressure in Pa: 100000 (1 atm)
Vf: Volume fraction
t: time in seconds
V: viscosity in Pa.s
Kxx: coefficient of permeability in cm^2

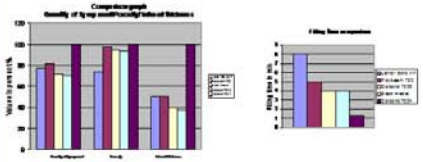




The anisotropy and isotropy of the media and the infused thickness have been verified. The porosity and density of each media have been found. **The Colbond 7004, the black media and the Polybeam 730 have similar permeabilities.**

Physical Properties

In order to compare the filling time and the quantity of syrup used, an E-glass panel (composed of 6 preform layers and 1 media) layer was infused

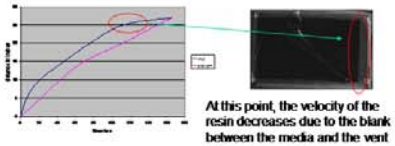


The thicker and the more porous is the media, the higher is the quantity of syrup used. (example *Colbond 7004*)

Behavior of Flow Front

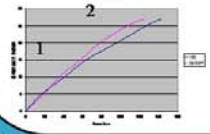
Through a panel of 6 preform layers

With distribution media on the top



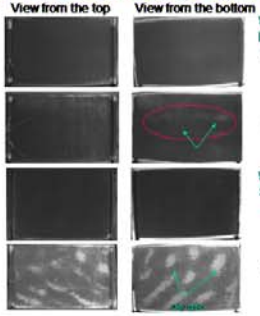
At this point, the velocity of the resin decreases due to the blank between the media and the vent line

With distribution media in the middle



In part 1, the flow front flows faster on the top because the resin has not arrived in the media. In part 2, the flow front on the bottom is faster because the resin is in contact with the media.

Infusion State Examples



In the case of the Colbond 7004, the velocity of the flow is too fast to infuse the top and the bottom of the panels. **The Colbond 7005, the black media and the Polybeam 730 have given similar results during all the investigation.** (*permeability value, filling time, infusion state*)