PREDICTING THE RESIN REDISTRIBUTION AFTER INJECTION IS DISCONTINUED IN VACUUM INFUSION LIQUID MOLDING PROCESSES

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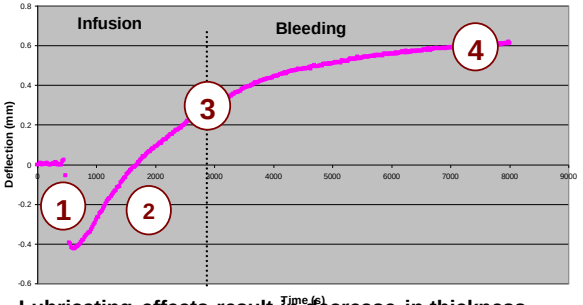
MOTIVATION

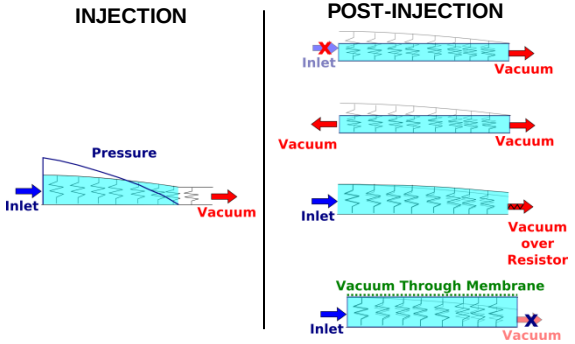
- In Liquid Molding Vacuum Infusion Processing with compliant molds and bags, the preform thickness changes with the pressure of impregnating resin.
- The thickness change and resin redistribution continues after the injection is discontinued. This influences the final fiber volume fraction and thickness gradients in the part.
- LCM Practitioners use heuristic rules such as applying vacuum on the inlet side and using a membrane on the bag side in an attempt to correct for this defect.
- It is necessary to describe the resin flow after injection is discontinued to predict the necessary dwell times and final steady state parameters and develop solutions to eliminate these aberrations.

THICKNESS VARIATION DURING VACUUM INFUSION PROCESSES



1. Lubricating effects result in decrease in thickness
2. Thickness increases due to pressure of incoming resin
3. Thickness variations damped by visco-elastic effect
4. Thickness continues to change after infusion is discontinued

POST-FILLING SCENARIOS TO REDUCE THICKNESS GRADIENTS

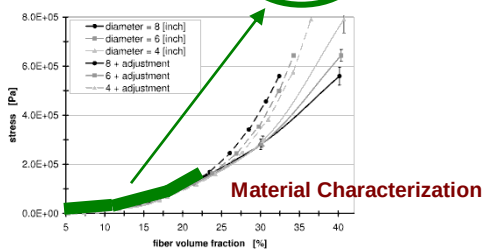


The resin transfer (injecting, venting) influences part dimensions and fiber volume fraction.

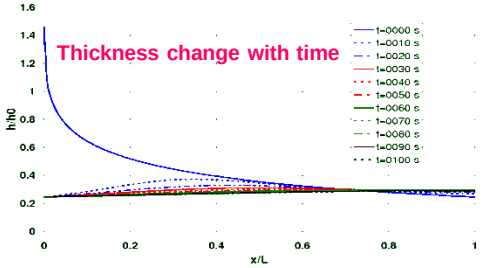
MODEL DESCRIPTION

Governing Equation

$$\nabla \cdot \left(\frac{\mathbf{K}\left(v_f\left(p_{atm}-p\right)\right)}{\eta} \cdot \nabla p \right) = \dot{p}$$



EXAMPLE: DRAWING VACUUM ON INJECTION LINE AFTER FILLING



Random Mat Preform: η=0.36 Pa.s

$v_f = 3.43 + 0.105 * p^{0.445}$

$K = 7.82.10^{-11} * (1-v_f)^2 / v_f^3$ m^2

CONCLUSIONS

- Development of pressure and thickness in VARTM part after the infusion can be reasonably predicted.
- Additional material characterization is necessary to couple pressure with deformation.
- Practical recipes for part improvement can be justified – and improved – using the modeling capability.

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