

# Active Control of Reactive Resin Flow in a Vacuum Assisted Resin Transfer Molding (VARTM) Process

R. J. JOHNSON AND R. PITCHUMANI\*

*Advanced Materials and Technologies Laboratory, Department of Mechanical Engineering, University of Connecticut, Storrs, CT 06269-3139, USA*

**ABSTRACT:** Flow of a catalyzed resin into a fibrous preform is an important step governing the quality of composite parts fabricated using liquid molding techniques. This article presents numerical and experimental investigations on novel means of active flow control to steer the resin flow through the preform so as to eliminate void entrapment and dry spots. The active control is based on locally heating resin to reduce viscosity and, thereby, enhance preform permeation at locations of flow lag in the preform throughout the filling process. A consequence of heating the reacting resin is an accelerated cure reaction that irreversibly increases resin viscosity with cure. A balance between the competing sources of viscosity change form the basis for the model-based control of localized heating. Focusing on a vacuum assisted resin transfer molding (VARTM) process, numerical modeling is coupled to an active control strategy in a simulation environment, and parametric studies are presented over a range of preform lay-ups and constraint on the maximum cure levels at the completion of the filling stage. In addition, the active control system is experimentally implemented and is shown to be successful in fabricating composite panels, without void entrapment or premature resin gelation, while reducing fill time and resin wastage.

**KEY WORDS:** induction heating, vacuum assisted resin transfer molding (VARTM), active control, permeability variations, resin cure, chemorheology.

## INTRODUCTION

VACUUM ASSISTED RESIN transfer molding (VARTM) is a low cost alternative to other composite manufacturing methods and is also suited for fabrication of large and complex unitized structures. In this process, a single-sided hard mold is used on the one side and the second side is formed by a vacuum bag; fiberglass preform material is placed between the mold and the vacuum bag and sealed. A vacuum is drawn on the system that compacts the preform and draws reactive resin from the mold inlet ports, through the porous preform, to the vacuum vents. Following the filling stage, the resin-saturated

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\*Author to whom correspondence should be addressed. E-mail: r.pitchumani@uconn.edu