Theoretical and Experimental Evaluation of a Segmented Injection Line for Resin Flow Control In VARTM

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ABSTRACT

During the infusion of resin into a closed mold that contains the preform in the VARTM process, resin flow is often affected by the inherent variations in permeability resulting from the part design and features as well as the variability associated with the mold lay-up. Current injection methods used for VARTM provide very limited controllability of the resin flow within the mold which results in part defects including dry (unfilled) regions and voids. Improved control of resin flow appears possible with several approaches like developing a controllable resin injection line which provides real time modifications to the flow front. The objective of this paper is to study the performance of a controllable (smart) resin injection line that provides real time control of the resin flow thus minimizing part defects. A smart injection line has controllable segments that can be actuated with a computer or a suitable actuation method to initiate or terminate resin flow in a region. Simulations of different smart injection line configurations for various mold geometries using several FEA models are studied, and the effectiveness of the smart line injection is analyzed under different senerios including variable mold permeabilities as well introducing more complex features in the mold. Results indicate there is a significant decrease in the void area with the segmented injection line. Better flow control is achieved by changing the lengths of the injection line segments and using suitable control action both of which are mold dependent. The effectiveness of this methodology is also demonstrated by conducting experiments that use feedback from resin sensors and actively control the resin flow in the mold.