Simulation of the Vacuum Assisted Resin Transfer Molding Process

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Abstract

A process model that includes the coupled phenomenon of resin flow, preform compaction, and resin cure is developed and used to simulate the infiltration of multi-axial, non-crimp carbon fiber fabric with the A.T.A.R.D. SI-ZG-5A epoxy resin using the vacuum assisted resin transfer molding (VARTM) process. The objective of the study was to investigate the resin flow and preform compaction behaviors during the VARTM process. Flow of resin through the distribution medium and preform is modeled as flow through porous media. During the infiltration process, it is well accepted that the total pressure is shared by the resin pressure and the pressure supported by the fiber network. With the progression of the resin, the net pressure applied to the preform decreases as a result of increasing local resin pressure. This leads to the springback of the preform, and is called the springback mechanism. On the other side, the lubrication effect of the resin causes the rearrangement of the fiber network and an increase in the preform compaction. This is called the wetting compaction mechanism. The thickness change of the preform is determined by the relative magnitude of the springback and wetting deformation mechanisms. The finite element/control volume method is used for the numerical analysis. The simulation results are compared with the experimental data. The parameters verified includes the flow front location, resin pressure and preform thickness change. With accurate inputs, the flow front locations and resin pressure distribution can be accurately predicted. The predicted transverse displacements agree well with the experimental measurement qualitatively, but not quantitatively. The reasons for the differences are discussed, and further investigations are recommended to develop a more accurate compaction model.