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Minyoung Yun, Tess Carella, Pavel Simacek, Suresh Advani

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Stochastic modeling of through the thickness permeability variation in a fabric and its effect on void formation during Vacuum Assisted Resin Transfer Molding

Minyoung Yun, Tess Carella, Pavel Simacek, Suresh Advani

Department of Mechanical Engineering and Center for Composite Materials

University of Delaware

Newark DE 19716

Abstract

Resin flow during Vacuum Assisted Resin Transfer Molding (VARTM) process, when distribution media (DM) is placed on top of the reinforcement, is largely affected by variation in through the thickness permeability of a woven fabric. The variation in permeability is due to the random pinhole regions around the junctions of fiber tows as they are woven together to form a fabric preform. We characterize and model this pinhole effect on resin flow with the aim of exploring the role of DM permeability (K_{DM}) on void formation. It was found that percentage of voids increases with higher K_{DM}. Five hundred simulations were executed for low, medium and high K_{DM} values and their effect on resin flow and void formation was investigated. Twenty experiments for each DM case were conducted. Flow along the bottom surface was recorded with time. It was observed that the flow front along the bottom became more uneven and irregular with higher K_{DM}, which resulted in higher percentage of voids formed during the process. The numerical simulations qualitatively and quantitatively agreed with the experimentally measured behavior exhibiting higher percentage of unfilled region with increasing DM permeability.