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Simulation of Cure Kinetics and Process-Induced Stresses in Carbon Fibre Composite Laminate Manufactured by a Liquid Composite Molding Technique

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Abstract : Vacuum Assisted Resin Transfer Molding (VARTM), a cost effective method of Liquid Composite Molding (LCM), is a single step process where the resin, at atmospheric pressure, is infused through a preform that is maintained under vacuum. This hydrodynamic pressure gradient is responsible for the flow of resin through the dry fabric preform. The current study has a slight variation to traditional VARTM, wherein, the resin infuses through the fabric placed on a heated mold to reduce its viscosity. The saturated preform is subjected to a cure cycle where the resin hardens as it undergoes curing. During this cycle, an uneven temperature distribution through the thickness of the composite and excess exothermic heat released due to different cure rates result in non-uniform curing. Additionally, there is a difference in thermal expansion coefficient between fiber and resin in a given plane and between adjacent plies. All these effects coupled with orthotropic coefficient of thermal expansion of the composite give rise to process-induced stresses in the laminate. Such stresses lead to part deformation when the laminate tries to relieve them as the part is released off the mold. The current study looks at simulating resin infusion, cure kinetics and the structural response of composite laminate subject to process-induced stresses.

Keywords : cure kinetics, process-induced stresses, thermal expansion coefficient, vacuum assisted resin transfer molding
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