SIMULATION BASED OPTIMISATION OF INDUSTRIAL MANUFACTURE OF LARGE COMPOSITE PARTS BY INFUSION

Anthony Pickett*

ESI GmbH, Mergenthalerallee 15-21,
65760 Eschborn, Germany †
akp@esigmbh.de‡
http://www.esi-group.com/

Tony Green

Israel Aerospace Industries Ltd.
Engineering Development Division.
Material Engineering Department 4479
Ben Gurion International Airport, Israel 70100
agreen@iai.co.il

Abstract

To date, manufacture of advanced composites in the Aerospace industry mostly uses pre-impregnated composite materials, tape laying technologies and autoclave curing for the production of large, high performance structures and components. These combined technologies allow toughened resins to be uniformly dispersed in a well controlled fibre system with a high fiber content, producing excellent mechanical stiffness, strength and fatigue resistance properties. However, there are drawbacks, including high material costs, limited shapeability, complex, expensive and time-consuming manufacturing, and short materials shelf life. As a consequence alternative manufacturing methods are being sought based on Liquid Resin Infusion (LRI) technologies in which the resin is infused only after all dry textiles are assembled to form the final composite component configuration. This assembly, prior to infusion, is called a preform. The advantages are lower material and material storage costs, indefinite shelf life (for the textiles) and the ability to manufacture integrated structures having complex geometries only limited by shapeabilty of the dry preforms.

Currently, LRI of large composite structures require 'trial and error' testing and considerable experience on the part of designers and manufacturers to get the correct set-up. The high cost and risks involved will often lead to overly conservative infusion designs with associated cost and performance penalties; or may lead to alternative, less competitive, manufacturing technologies and materials being adopted.

The scientific aim of the CEC INFUCOMP project (CEC, 2010) is to provide a full simulation chain for LRI manufacture of large aerospace composite structures dedicated to solutions required by the European Aircraft industry. Extensive materials testing for a range of dry fabrics and permeability characterisation is being conducted from which new constitutive laws will be developed. Software developments will be implemented into an existing infusion code PAM-RTM™ (ESI Group 2009), which has essentially been developed for Resin Transfer Moulding (RTM) processes. Some other specific developments include process optimisation, cost