RESIN DEVELOPMENT FOR RAPID COMPOSITE PROCESSING BY FLUID-CONTROLLED HEAT TRANSFER


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Summary. This paper reports on the steps towards developing a modified resin system for use with out-of-autoclave fluid-controlled heat transfer processing (Quickstep) to produce high quality composite laminates. Comparison between laminates processed by traditional methods of hot pressing and vacuum bagging is on-going using impact testing.

1 INTRODUCTION

Composites are now established as the lightweight material of choice for many high-technology applications. However, the need for complex processing techniques and the high cost of consumables, labour, energy and capital equipment are limiting their adoption in industries outside the aerospace sector. This has led to a drive in developing rapid, low energy manufacturing techniques as alternatives to traditional autoclave methods. In an autoclave, high performance composites are processed at relatively low heat up rates (i.e. 1-4 kmin^{-1}) in order to prevent non-uniform heating rates and runaway exothermic reactions, which are difficult to prevent or control due to poor heat transfer.

One way that these difficulties can be overcome is to use a fluid to transfer heat to and from the part. This is the basis of Quickstep, a fluid-controlled heat transfer process developed by an Australian company, Quickstep Technologies Pty Ltd, which can be used for
out-of-autoclave curing of advanced composites [1]. The process benefits from fast cure cycles and reduced capital, tooling and operational costs [1-3]. In addition, conventional aerospace pre-pregs cured using the high heat up/cool down cycles made possible by fluid enhanced heat transfer have been reported to show enhanced physical and mechanical properties [4].

This paper will report on the effects of processing on composite laminates produced with a resin specially developed for the Quickstep process.

2 EXPERIMENTAL METHODS

Pre-pregs were manufactured using the modified resin with carbon fibres. The resin consisted of a blend of 66% tri-functional to 34% tetra-functional epoxy and the ratio of epoxy to hardener was 70:30. From these pre-pregs, the laminates were produced using three techniques – hot press, vacuum bagging, both at 150°C for 4 hours, and Quickstep, also at 150°C but for 2 hours after a temperature ramp of 6°C from room temperature to 150°C. The laminates were then subjected to impact testing using a drop weight impact testing machine with the samples identically clamped to quantify the effects of processing.

3 RESULTS AND DISCUSSION

Good quality laminates were produced by all three processing methods using the modified resin. The impact test results for the laminates produced using hot pressing and vacuum bagging have been analysed and show that vacuum bagging produced samples with a lower modulus but with higher energy absorbed. The results from the Quickstep samples will be reported in the full version of this paper.

9 CONCLUSIONS

Use of a modified resin to produce carbon fibre laminates specifically for a fluid-controlled heat transfer process has been undertaken. Comparison with laminates produced by traditional processing methods is ongoing.

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