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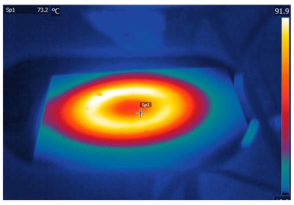
Induction Curing of Composite Panels

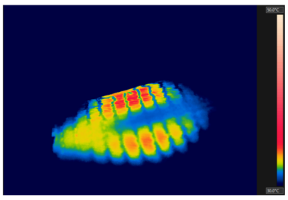
L R Pickard, C O'Keeffe, D Ivanov

Curing carbon fibre-epoxy panels by electromagnetic induction has been demonstrated, using an Ambrell Easyheat 8310 10kW system fitted with a flat coil. Panels can be heated as quickly as resin chemistry permits, minimising ramp time.

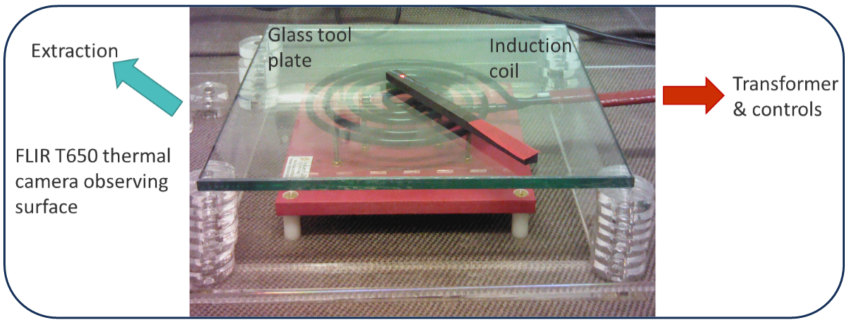
Tufting with multifunctional braids containing carbon fibre and copper wire was expected to facilitate faster heating at a given current due to improved through thickness conductivity. Such tufting has been shown to affect unidirectional and quasi-isotropic panels differently, with the former showing braids heating and changing the heat pattern compared to a 'blank' panel, and the latter showing braids appearing cooler than the surrounding areas, with thermal conduction to the colder areas of the panel appearing to dominate. It is therefore hypothesised that the wires within the tufts are not forming closed conductive loops, hence heating only by eddy currents or loops formed with the carbon fibres, any contact at the tufting point being unlikely to result in individual wire to wire contact.

In both cases, where pre-cured panels are heated at constant current, panels without tufts reach a higher temperature than panels containing tufts. This supports the above hypothesis, with the additional hypothesis that the higher temperature seen in the 'blank' panels may be due to lower mass compared to the tufted panels.





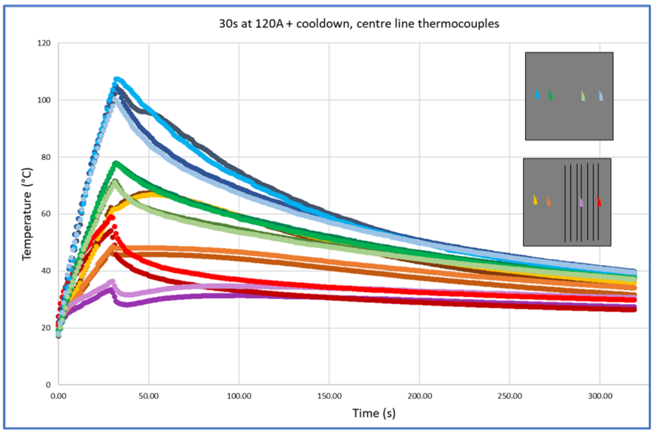
Above: Quasi-isotropic panels without (top) and with tufted braids during induction heating. Contrast adjusted to highlight that braids are cooler than surrounding material. Torus shape is a consequence of coil geometry.



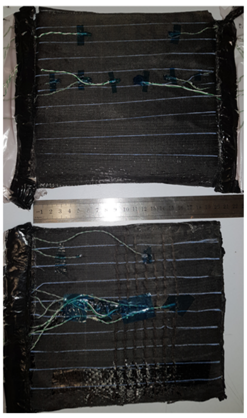
Multifunctional braid, 1cm.

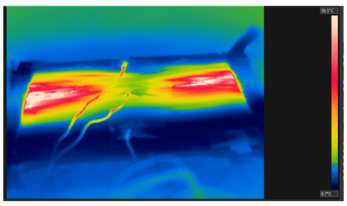
4 copper wires and 4 carbon tows.

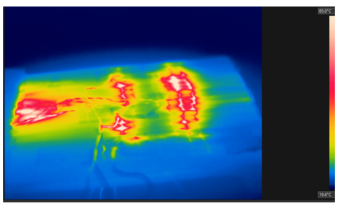
No contact between copper wires.



Example result- the UD panels shown (2 tests) each heated at 120A (227kHz) for 30s then allowed to cool. Blue and green lines show panel without braids. Panel with braids is red and purple lines (braid side) and yellow and orange lines (blank side). Thermocouple positions as on sketch.







These unidirectional panels were both cured by electromagnetic induction. The cured panels were heated at set current. Infrared camera images show the braids change the panel thermal profile, leaving the right hand side cooler and extending heat along the braids, but thermocouple data shows that the panel without braids reaches a higher peak temperature.

The braids change the thermal profile; but, perhaps due to additional mass, panels containing braids show a lower heating rate at fixed current. Thermal conductivity along braids is evident and seems to dominate over any induction heating. Tufting with this braid does not appear to form closed conductive loops of copper wire.

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