CASE STUDY

Radio Frequency Cure

Rapid, energy efficient curing of composites

Quick Facts...

Industry

- Aerospace, Automotive, Renewable Energy & Sports Goods

Challenges

- Energy efficient and rapid production of composites components.

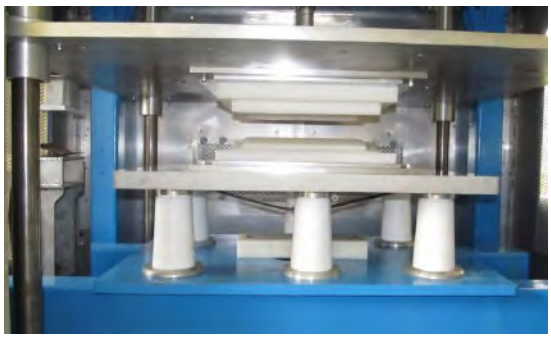
Sdution

Using RF for rapid production of high quality products.

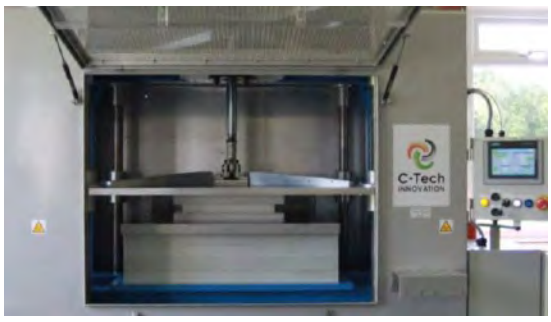
Benefits

RF Curing of composite materials has been shown to deliver the following significant benefits:

- RF selectively heats the product but not the tooling. This provides energy efficiency benefits and enables use of low cost polymeric tooling
- RF rapidly and volumetrically heats composite materials
- Rapid cure cycles are achieved, with particular benefits for thick components.



RF press set-up with polymeric tooling



RF press system

Background

Abstract: Glass Fibre reinforced composite components can be cured using radio frequency (RF) heating. RF heating is a volumetric technique which enables rapid, uniform and energy efficient heating of materials to be achieved. Heat up rates of greater than 10°C/min were achieved with simple structures with energy usage ≤1KWh/Kg of material. This represents a significant improvement on existing cure technologies such as autoclaves. The use of RF is expected to be particularly valuable for curing thick components (e.g. 10-50mm thick components) where the volumetric nature of RF, by providing uniform heating throughout the sample, has potential to speed up production of these challenging components.

Challenges

The market for composite materials is growing rapidly, fuelled by a need for lightweight materials with good mechanical properties in a range of markets. Among others, these markets include components for aerospace, automotive, renewable energy and sports goods. For the automotive sector, adoption of composites in mass production vehicles will be dependent on reduction in cycle times for component manufacture and increased throughput. Targets for cure cycles of <3mins have been quoted by car manufacturers. For the renewable energy sector a key challenge is to reduce the time taken to cure thick components (often 50-100mm thick).

The need to minimise temperature gradients within components means that traditional heating methods, which rely on slow heat transfer from the component surface, often require a cure time of over 24h. In all sectors there is a need to reduce the energy consumption of the curing process. Current processes involve heating and cooling metallic tooling of high thermal mass which necessitates high process energy usage. RF curing has shown potential to address these key industry challenges by reducing cure cycle time, lowering energy use and providing uniform heating of thick components.

Project Results A proof of concept study has been carried out to demonstrate the benefits of RF curing. This work focused on production of glass fibre reinforced composites with an epoxy matrix.

Key project results include:

- ***Production of a versatile RF press system***: This press is capable of curing components with controlled pressure as well as under vacuum.
- ***Design and fabrication of polymeric tooling systems:*** Tooling is made from low cost polymeric materials which are transparent to RF
- ***Production of composite panels with good mechanical properties***
- ***Identification of cure cycles for composite panels***: Cycles for production of components with good mechanical properties were identified. Heat up rates of >10°C/min were achieved with energy usage of ≤1KWh/Kg. Further improvements are believed possible.
- ***Demonstration of benefits for thick components***: 20mm thick samples were shown to heat uniformly and reach cure temperature within 45mins.

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