Simulation of an Electrically Heated Carbon Fibre Fabric

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Abstract

For an increasing portion of various construction components carbon fibre reinforced plastic is used, since this material combines desirable properties as high stability and low weight. Carbon fibre reinforced plastic consists of carbon fibre fabric which is drenched in resin that then gets cured. To accelerate the curing of the resin, it is common practice to apply heat. The fibretemp® method allows for efficient creation of a heating system within the fabric by using the electric resistance of the carbon fibres to transform electric energy into heat [1]. However, depending on the geometry of the fabric, prediction of the resulting heat distribution can be challenging.
The aim of this project was to establish and to validate a simulation model with the simulation software COMSOL Multiphysics® for the heat distribution within a carbon fibre fabric when the fibretemp® method is applied.

The Joule Heating interface combined with the Curvilinear Coordinates interface to account for the anisotropic thermal conductivity was used for the simulation of a square single layer fibre fabric. Specific required parameters, e.g. the contact resistance between the carbon fibres and the heat transfer coefficient, were assessed in differing experimental settings.

For validation the numerical results were compared with measured data. For this purpose, five temperature probes were installed on the back of the fabric. The results show large concurrence of the simulated and measured values. The highest temperature during heating is present in the centre of the fabric with gradual decrease towards the outer edges (see Fig. 1).

The established model is appropriate to investigate the basic heat distribution within a square fibre fabric. In future projects this simple model can be improved by implementing the anisotropic electric conductivity as well. In addition, more complex geometries of the fabrics can be analyzed.

Reference
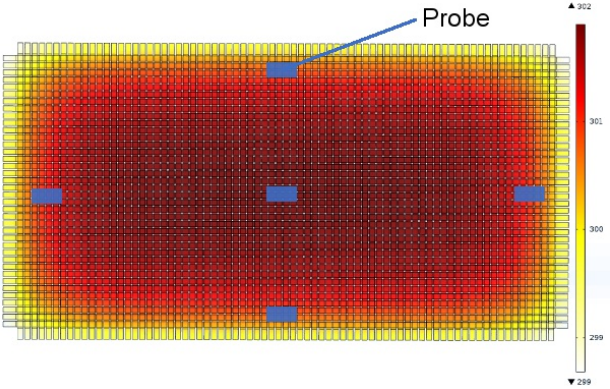[1] www.fibretemp.de/en

Figures used in the abstract

Figure 1: Simulation results and the position of the temperature probes.