Environmental Compensation Factor Influence on Composite Design and Certification

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ABSTRACT

Most polymeric materials, whether in the form of a composite matrix or a polymeric fiber, are capable of absorbing relatively small yet potentially significant amounts of moisture from the surrounding environment. The physical mechanism for moisture gain, assuming there are no cracks or other wicking paths, is generally assumed to be mass diffusion following Fick's Law. While material surface in direct contact with the environment absorbs or desorbs moisture almost immediately, moisture flow into or out of the interior occurs relatively slowly. This absorbed water may produce dimensional changes, lower the glass transition temperature of the polymer, and reduce the matrix and matrix/fiber interface dependent mechanical properties of the composite (effectively lowering the maximum operational temperature of the material). Because absorbed moisture is a potential design concern for many applications, testing of the airframe materials is usually included in the process of structural substantiation after representative moisture exposure. According to Fick's Law for moisture diffusion in composites, thick laminates under service temperatures may take a significantly longer duration depending on the thickness. Hence, some realism needs to be taken into account during this analysis, particularly for the thicker laminates. Moisture absorption characteristics of composites, which follow Fick's second law, can be coupled with realistic environmental data to design structurally efficient and economic composite components. This research will provide guidance to establish practical levels of moisture content and corresponding environmental compensation factors for composite structures.