CURE SYSTEM FOR CARBON FIBER-REINFORCED COMPOSITE COMPONENTS

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Objectives

The objective of this project is to introduce a system that generates heating for components manufactured using carbon fiber and resin, enabling the resin curing process. This system, wherein heat production is achieved through Joule effect, aims to establish precise, efficient, and autonomous control by leveraging relationships between electrical parameters and thermal outcomes.

Materials and Methods

To achieve the proposed objective, the resin-impregnated carbon fiber component is subjected to an electrical voltage, and the flow of electric current through the carbon generates thermal energy through the Joule Effect. Temperature control is achieved using an electronic device, the "Raspberry Pi," serving as the central controller. Infrared temperature sensors are installed to monitor the real-time temperature of the carbon components. The control system is responsible for adjusting the heating power based on the data measured by the sensors, modifying the voltage and electric current conducted through the component. Furthermore, safety mechanisms are implemented to interrupt the process in the event of component overheating or signs of incipient fire, which can be identified by temperature sensors or smoke detectors. Lastly, software is implemented to enable remote monitoring of the curing process..

Results

Experiments were conducted for the curing of a carbon fiber tube piece with dimensions of approximately 1.30 meters in length, 0.75 millimeters in thickness, and 29 millimeters in diameter. In this test specimen, an electrical current of 4.97 amperes and an electrical voltage of 0.64 volts were applied, resulting in a temperature increase of 30°C, reaching 55°C in 8 minutes. This temperature was maintained for 2 hours. Thus, the amount of heat generated during the curing of the piece was 22902 joules. Considering the PVC tube in which the carbon fiber piece was inserted, its internal volume is approximately 0.07 cubic meters. Therefore, when compared to a case of heating through the combustion of fossil fuels, an energy expenditure of 58019 joules would be required.

Picture 1: Power supply

Picture 2: Prototype of the system

Conclusions

In this manner, during this initial phase of the research, we can deduce that heating through the Joule Effect decreases the energy expenditure required to maintain a temperature differential of 30°C with the external environment by nearly 60%, as compared to heating through the combustion of fossil fuels. Ultimately, this facilitates the progression of the research, now transitioning to the stage of temperature control system development and software implementation.

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