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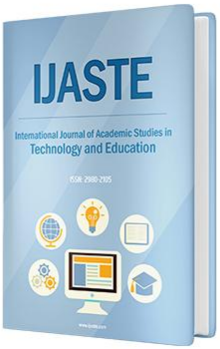

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SIMULATION AND ANALYSIS OF HEAT TRANSFER AND CURE PROGRESSION IN THE PULTRUSION OF THERMOPLASTIC COMPOSITES

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Abstract: This work presents the numerical modelling of the pultrusion process for Elium®-based thermoplastic composites, with an emphasis on coupling heat transfer and cure kinetics to predict the curing degree and temperature distribution along the die. A thermochemical model was developed in COMSOL Multiphysics®, incorporating the exothermic heat released during polymerisation. The model implements heat transfer and cure kinetics equations using a modified Kamal–Sourour formulation and reflects realistic process conditions, including die zoning, heating temperatures, pulling speed, and material properties. Simulations were conducted to predict temperature and curing profiles both along the die length and across the composite cross-section. The results enabled the identification of thermal hotspots and provided insight into the spatial progression of curing. It was observed that curing initiates at the die wall where heat transfer is most intens and advances towards the core, with complete curing predicted approximately 700 mm from the die inlet, consistent with experimental measurements. This study not only validates the proposed thermochemical model but also enhances the understanding of Elium® composite pultrusion, supporting process optimisation and defect minimisation. The work was carried out within the framework of the EuMINe network, fostering collaboration and knowledge exchange between institutions and laying the foundation for future joint research in thermoplastic composite processing.

Keywords: thermoplastic composites; pultrusion; heat transfer; cure kinetics; numerical modelling.