Abstract

The present thesis focuses on the study and the modeling of the behaviors occurring in injection pultrusion processes to produce fiber reinforced thermoset polymers. The high market appeal of pultruded profiles and the cost-effectiveness of the process led the pultrusion production to a constant growth in the last twenty years. The key factors determining the success of this technique are the continuity nature of the process the flexibility in material choice and the high customizability of the fibrous reinforcing architecture.

The injection pultrusion technique is the evolution of the conventional pultrusion process. The main difference between the two techniques stands in the way to impregnate the fibrous reinforcement with the resin. Indeed, in injection pultrusion, the pressurized resin is forced through the fibers within a closed injection chamber. The main advantage of this technique with respect to the conventional one consists in a better controllable filling of the reinforcement. Moreover, this version of the process remarkably reduces the direct contact between the resin and working environment, benefiting the operators.

Despite the wide spreading of the pultrusion technique, in many cases the set of the operative parameters is defined by trial and error approach, on the base of the experience of the process designer. The main reason of this are the high number of process parameters and the presence of variables not easily definable and controllable, e.g. the degree of cure of the resin system or the exothermal heat released.

The present thesis proposes a modeling approach to predict the main material behaviors in pultrusion. The modeling methodology has been structured in four steps, namely the matrix-reinforcement system characterization, the modeling of the impregnating flow, the modeling of the thermochemical evolution along the pultrusion die and the mechanical modeling of the stress-strain fields and the pulling force. The numerical models are validated by experimental results.