Online Measurement of Resistant Load in Pultrusion

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Abstract. Injection pultrusion (IP) process, which deceptively may look quite simple, is based on several different thermo-chemical and physical phenomena which interact and influence each other. The advancing fibers are pulled through a narrow tapered cavity, a.k.a. injection chamber, that is the first section of the IP die. Their compaction walls generate a first aliquot of resistance to the pulling force. In this zone, thermoset resin is injected and impregnates the reinforcement. The resin is in liquid state, and therefore it has an interaction of viscous nature with the other bodies of the system. Viscous resistance depends by the value of resin viscosity and the thickness of the resin layer between fibers and wall. Viscosity initially lows down when temperature raises from room temperature until the curing process starts and the solidification provokes a sharp rise of viscosity. In first segment resin is liquid, and therefore incompressible. Its compression generates a hydrostatic pressure of several tens of bars, which presses the sections of material downstream, where the resin gets the solid state, to the wall increasing frictional resistance. Finally, thermal expansion and chemical shrinkage influence the contact at the solid state. It is clear that to achieve a satisfying comprehension of the process an integrated approach is necessary.

To measure all these phenomena and the relative loads is as challenging as fundamental. In this work a quantitative measure of resistive loads in a laboratory scale IP line is presented. In particular, in each point of the die, the resistance has been isolated and measured. Particular attention was given to the impact of pulling speed on the force necessary to move the system. The post-process analysis of the acquired data allowed to define the behavior and the impact of each of the phenomena described above.