Optimisation of Mould Filling Parameters for the Injection/Compression Moulding Process

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ABSTRACT

The Injection/Compression Moulding (I/CM) process is one of several Liquid Composite Moulding processes that have been developed over the past decade. I/CM involves liquid thermoset resin being injected through a porous fibre reinforcing preform, held within a partially closed, rigid two part mould. On completion of resin injection, the mould cavity is closed to the designed part thickness. For design of an I/CM process, several process parameters must be specified. The choice of the injection flow rate, mould cavity thickness during resin injection, and the rate of compression during the final compaction phase are critical. Sub-optimal processing parameters can result in excessive manufacturing cycle times, and/or the requirement of oversized injection and compaction machinery. Through process optimisation with regards to both physical and economic requirements an ideal processing solution can be identified for any specific mould geometry.

A process simulation has been developed to predict the transient fluid injection pressures and total compaction forces in I/CM processes. This flow simulation has been verified through an experimental programme. An ideal I/CM process requires minimal injection pressure and compaction force, and results in a minimal process cycle time. These requirements are conflicting, as using minimal injection pressure and compaction force, inevitably results in a maximum cycle time. To allow the efficient optimisation of critical I/CM process parameters, Response Surface Methodology has been adopted. Through minimising a weighted process performance indicator the optimal processing parameters for several mould geometries and economic scenarios have been evaluated. The results of this optimisation study demonstrate the importance of careful parameter selection when incorporating mixtures of injection and compression flows.