Modeling and optimization of the injection molding process with OpenFOAM®

József Nagy, Georg Steinbichler

Institute of Polymer Injection Moulding and Process Automation, Johannes Kepler University, Altenbergerstraße 69, A-4040 Linz, Austria, +43 732 2468 6730, jozsef.nagy@jku.at

In the plastic injection molding industry the reduction of the development time of tools and machines has been one of the most important issues in the last decades. A progressive trend has been emerging during the last years, where the computer-aided optimization has been proven as one of the key steps in achieving this goal. Commercial products offer 'click-along' solutions, however, the results of these black-box systems have been proven to be only correct in certain cases. For a serious and general optimization methodology of development the correctness of the results has to be guaranteed for all possible geometries, processing conditions as well as materials.

OpenFOAM® offers an excellent foundation for the development of a tool for the description of plastic injection molding. The process itself consists of several steps. During the first step a mold with the shape of the final product part is filled. Since the viscosity of the liquid polymer is in the order of magnitude of 10-10000 Pas, the needed pressure to maintain a certain volume flux is high (approx. 100-2000 bar). This implies high forces in the machine in order to guarantee safety during production. Therefore, it is of utmost importance to know the needed forces beforehand. A simulation has to correctly describe the pressure evolution during the process (in particular the maximum pressure). On the other hand, it is important to correctly describe the movement of the flow front during filling. This information is needed to predict, at which point of time the filling process is finished and the subsequent packing phase starts.

With the implemented model a good agreement is found between experimental and simulation results (see figure 1). This shows, that with the help of the implemented tool within the OpenFOAM® framework possible processing conditions can be eliminated, where safety limits are exceeded. On the other hand it is possible to optimize conditions during the process in order to improve selected material. With this, the implemented tool can be an intrinsic part of the future development of the injection molding process and machines.

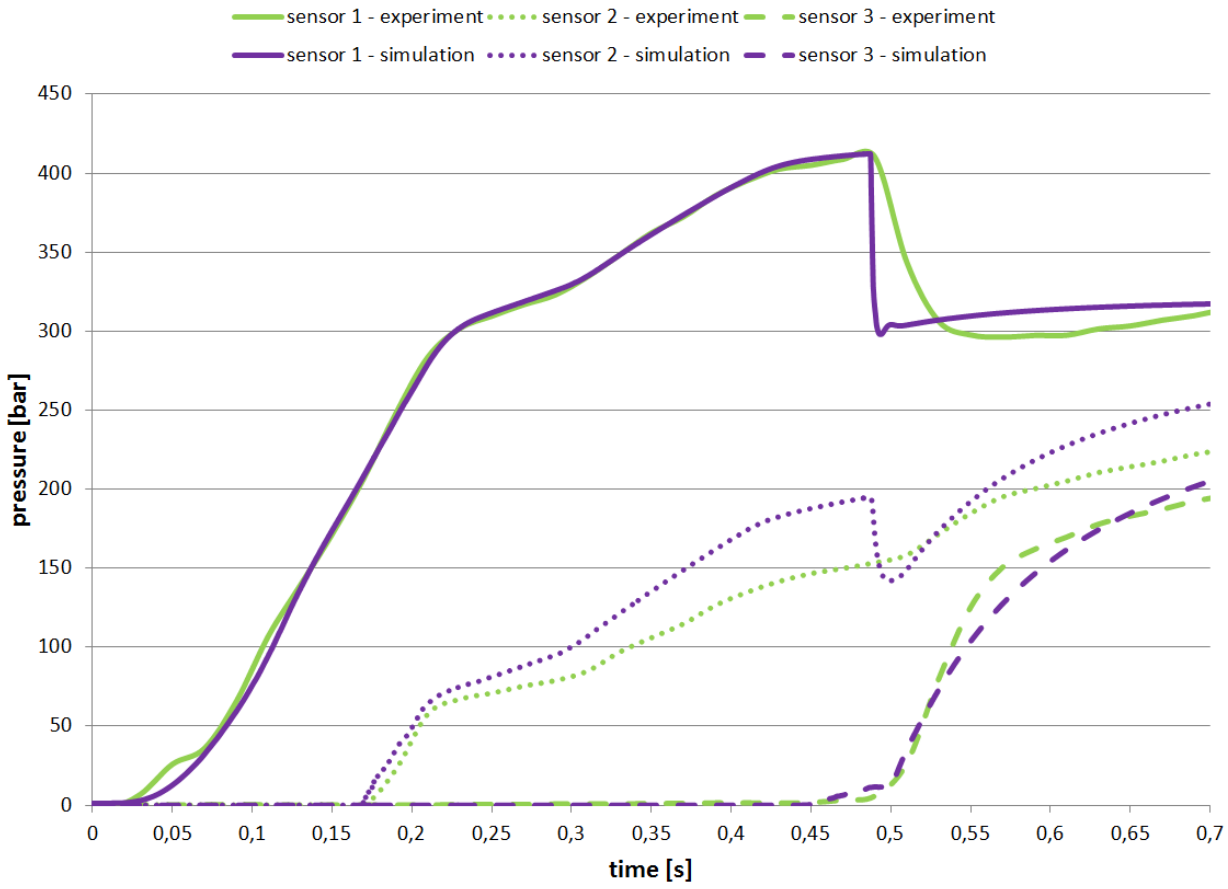

Figure 1: Pressure evolution during a typical injection molding process at three sensor locations in experiment and simulation