CAE Software for 3-D Polymer Flow: Remylop

Topics

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As a tool to support the development and design of polymer injection molded parts, the injection molding analysis program IMAP was previously developed and has been put into practical use. The application of IMAP, however, is limited to thin-walled parts because it considers two-dimensional polymer flow only. In order to apply to thick-walled parts and improve accuracy in analysis of thin-walled ones, a full three-dimensional injection molding CAE software "Remylop" has been developed for the first time in the world.

Remylop considers the polymer flow during injection molding as the three-dimensional nonisothermal and compressible flow of high viscous non-Newtonian fluid with free surface. Consequently, Remylop adopts the full three-dimensional equation of continuity, the stokes equation and the energy equation considering viscous heating. In order to share the polymer data with IMAP, the constitutive equation for non-Newtonian fluid and the state equation are the same as those of IMAP, respectively. The hardest problem for the practical use was the reduction of the calculation time. The analysis within the practical calculation time has been realized by using the pseudo-concentration method for tracking free surfaces and using the two step rational Runge-Kutta method for the time integration of the stokes equation. Remylop is also applicable to hybrid models constituted of beam, shell and solid elements, broadening its application range of practical analyses to large moldings.

The below are two examples of the polymer flow analyses using Remylop. The first is the analysis using a 4-ribbed square plate (**Fig. 1**), which was carried out for the software verification. The change in the polymer pressure with time calculated using the half mesh model well agrees with the experimental results (**Fig. 2**). The simulated temperature distribution is shown in **Fig. 3**. The simulation results represent well the large temperature gap in the surface vicinity and high-temperature region at the rib base, which are both the characteristics of the temperature distribution of the injection molded parts. The second example is the application to an automotive steering wheel, which is a typical thick-walled part (**Fig. 4**). Since the steering wheel used for the analysis has steel cores inside, injected polymer flows around the core and therefore weld lines are generated. The positions where the weld lines appear in the simulation correspond to those in the actual steering.

Many actual applications prove that Remylop is a useful software for the design of injection molds and parts.

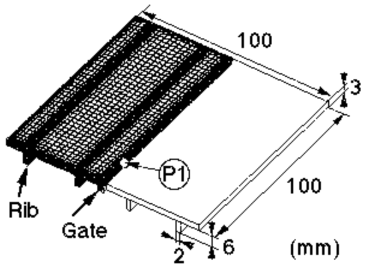

Fig. 1 Mesh model of a 4-ribbed square plate.

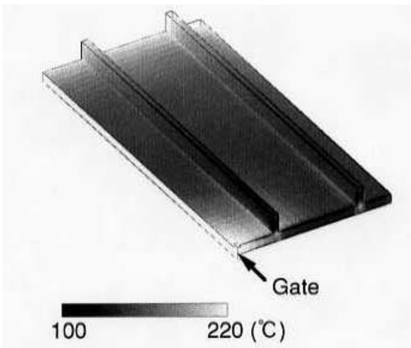

Fig. 3 Simulated temperature distribution at the end of the mold filling.

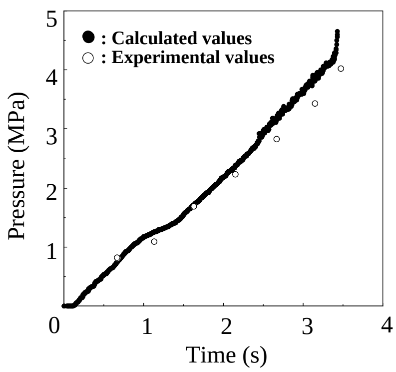

Fig. 2 Comparison of calculated and experimental pressures at P1 shown in Fig.1.

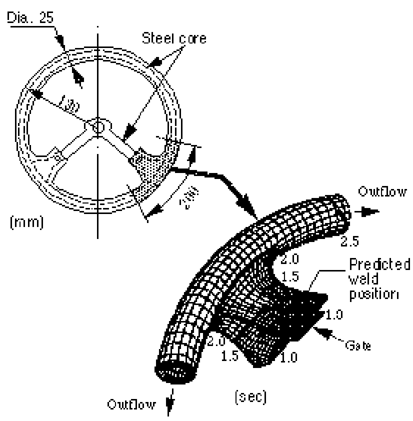

Fig. 4 Simulated filling patterns of an automobile steering wheel.