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Influence of the Process Control Type on Thermoplastic Injection Moulded Part Quality

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This paper analyses the incidence of the process control type on the production stability of thermoplastic injection moulded items. Quality criteria are part weight, dimensions and mechanical properties (impact toughness). Three process control modes were assessed. The first one is a regular control of the hydraulic pressure (HPC), the second, an advanced closed loop control of the polymer melt pressure during the holding stage (PPFC), and the last, a cycle-to-cycle self-adaptive control (APPFC). In the last case, the filling stage is used to record the experimental data required to feed a simplified analytical model, which calculates the holding pressure to be applied to the polymer according to the actual thermal and rheological state of the injection process.
A significant benefit on parts weight stability of the PPFC and APPFC process controls, compared to the HPC one, was proved whatever the configuration is (different materials, moulds and machines). The ability of these systems to reduce the scattering of volume moulding shrinkage was also highlighted in one specific case (PBT). Moreover, it was observed that the total volume shrinkage is of lower absolute value for PPFC and APPFC modes than for the classical one. This experimental result was explained theoretically by transposition of injection moulding cycles on a PVT diagram. Regarding impact strength, the slight negative effect due to additional internal stresses induced by the polymer pressure based controls with (APPFC) or without model (PPFC) remains of secondary importance compared to the benefits obtained on dimensional precision and stability. On the other hand, these modes generate a decrease in the scattering of the impact strength.