



Manufacturing and comparison of Copper vs. Steel plastics injection molds

Introduction

In the field of the injection of polymers, the requirements in terms of productivity and profitability are very high. Cycle time when injecting technical parts is mainly limited by the cooling time. Playing with the higher thermal conductivity of an Ampcoloy versus steel, cycle time can be notably shortened.

Executed tasks

- Study of the conception of a mould
- Construction of a mould out of Ampcoloy
- Injection of parts with measurement of pressures and temperatures
- Comparison of the results with the Moldflow simulation software
- Cycle time optimisation

Conception and construction of the mould

The plastic injection machine of the EIA-FR high school is equipped with a quick mold exchange system, so called Handy Mold®. The mold to be built takes over the dimensions imposed by this system.



Modelling of the mold with I-Deas system

The mold has been first modelised with the I-Deas10 CAD software and then it has been CNC-machined with a milling

machine. Injection grooves and injection channels have been EDM-machined. The mold material is a copper alloy supplied by Ampco Metal SA in Marly-Fribourg Switzerland, so called Ampcoloy® 940. The EDM-ing electrodes have been produced out of Ampcoloy® 972. The AA940 has an acceptable Brinell hardness of 210 HB, with a heat conductivity 12 times better than steel.



Mold out of Ampcoloy 940® mounted on the Handy Mold system

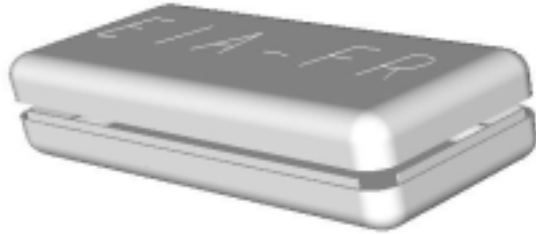
Normalised accessories from the Hasco Company have been chosen, such as guides, ejectors or the injection nozzle.

Injection

The high school owns a Netstal Synergy 600 plastic injection machine. An independent thermoregulator insures the cooling of the mold down to 30° C by oil circulation. The injected plastic is a homopolymer polypropylen (PPH). The temperature of the injected mass stands at 240° C and the mold temperature has been set at 50° C. It was necessary to run a serie of tests to obtain an optimised injection process by changing the parameters of the injecting machine and



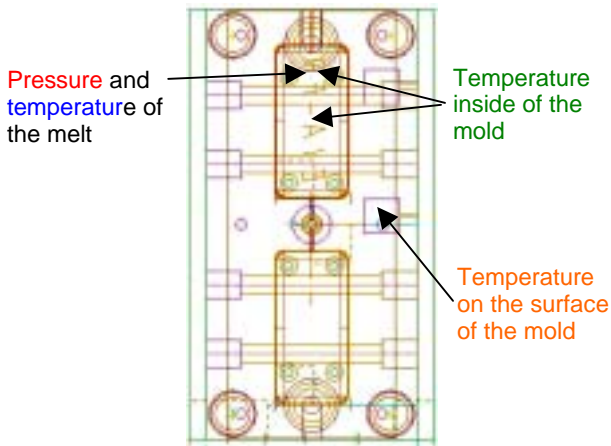
by modifying of the mold. The manufactured part is a simple plastic box.



Box out of PPH

Acquisition of the measured parameters

Since we are testing the mold material, temperature and pressure transmitters have been installed in the mold and on the surface of the mold in contact with the injected plastic mass to acquire the measured parameters. The pressure and temperature transmitters are connected via an amplifier to an electronic measuring equipment, so-called SPIDER. This SPIDER is linked to a PC and the measured parameters are acquired with a Catman software from HBM.



Position of the transmitters

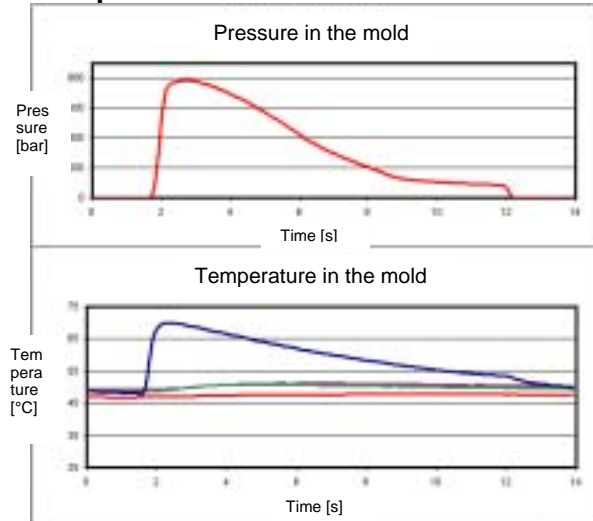
Simulation with Moldflow

A simulation of the injection process has been made with the help of the Moldflow Plastics Insight software in parallel to the mold construction as part of a separate diploma project.

The parameters such as the type of utilised injection machine and the injected plastic have been defined according to the real model. The simulation has been made

with an Ampcoloy® 940 mold and a standard tool steel (1.2363) mold.

Comparison of the results



Pressure and temperature when injecting

The injection time is below 1 second and the maintaining of the pressure is immediate. The pressure values delivered by the transmitters are slightly lower than the one indicated by the injection machine, 600 bars measured with a maintaining pressure of 850 bars. The difference is due to the pressure drop in the injecting channels.

The temperatures measured inside the mold are stable at 50° C and the injected material cools down rapidly when in contact with the mold.

The simulation of the injection cycle time between a steel mold and an Ampcoloy® mold shows an advantage of more than 20% in favor of the Ampcoloy®

Conclusion

The productivity can be augmented thanks to a reduced cycle time when using a copper alloy in a mold. It is not necessary for the whole mold to be made out of Ampcoloy®, but only the cavities and inserts. The injection parameters given by the simulation help to optimize the whole cycle, these are theoretical values which have to be interpreted in consequence.