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Expectation of the parts quality on the ground the simulation of the injection moulding process

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ABSTRACT

Purpose: The aim of this paper was to present results of researches concerned to predestining quality of polymer parts created by injection moulding method. The estimation of structural solution quality was made on the grounds of the injection moulding computer simulation. Results of studies were compared with predictions presented in professional literature.

Design/methodology/approach: Series of injection moulding computer simulations were carried out for different structural solutions of chosen polypropylene part. Supported by taken results predicted quality of part was evaluated. Next literature studies were carried out to compare taken results with instances happened in industrial practice. The analysis of computer simulations usability in designing process of polymer products was made. For the simulation investigations a professional computer software Moldflow Plastics Insight ver. 6.1. has been employed.

Findings: Modern computer programs for injection moulding process simulation allow us to predict the quality of final product. Applied algorithms and calculation methods makes elimination of structural defects possible, on the stage of production process designing. Using computer methods to design and optimization of structural conclusions of parts, cut down time and costs of initiating to production.

Research limitations/implications: Authors didn't have the possibility to inject part in every considered in the article structural versions. In the future it is planed to realize the appropriate injection moulds that make possible the presentation of probable structural errors of polymer parts. Moulds like this could have big educational meaning.

Practical implications: Results received during studies are going to be used during didactic studies with students and during trainings for injection moulding machines operators.

Originality/value: Results of studies presented in the article permit us to understand the meaning of simulating computer programs application in designing and initiating to production of polymer parts

Keywords: Computer assistance in the engineering tasks and scientific research; Modeling of polymer flowduring injection molding process; Mold flow analysis; Image analysis

METHODOLOGY OF RESEARCH, ANALYSIS AND MODELLING

1. Introduction

Polymers and its composites processed by injection method widespread in many branches of modern industry. Participation of fulfilled materials (composites) in products, which are destined for using not only in everyday life still increase. In that case, conducting studies aim at deep came to knowing the phenomena proceeded during wide known as polymer processing, is well grounded. Often happens that error committed by constructor, in mold designing phase, decided about failure during implementation product into production. This paper is the test of injection process computer simulation usability to elimination of those errors.

2. Methodology

In below paper results received during investigations of composite polypropylene with chalk were presented. Polypropylene made by SIRMAX company with trade name ISOFIL H20 TC F Bianco was used. Weight content of chalk was 20%. Within the framework of simulation studies series of numerical analyses were preformed, which aim at computer modeling of composite injection process. In this order professional computer program Moldflow Plastics Insight version 6.1 was used. For appropriate conducting of analyses it was necessary to insert material data. For this target data base which was the integral part of simulation program was used.

In the Figure 2 FEM model was presented. Conducting the simulation required using of model that fulfilled particular requirements (for example number of finite elements on the thickness of the part wall – minimum 4). Additionally taking into account effects of inertia and gravitation into numerical calculation was forced.

Into studies rectangular prism with dimensions: 100 mm (length), 50 mm (width), 30 mm (height) as a molded part was used. Thickness of wall was 2 mm.

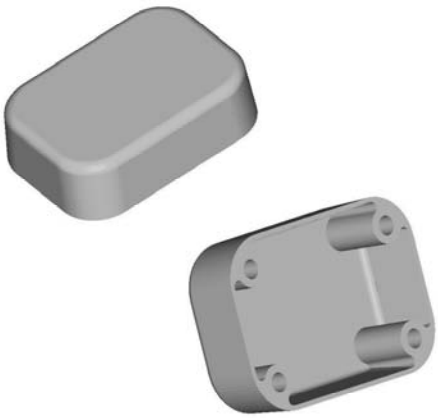


Fig. 1. 3D model of molded part

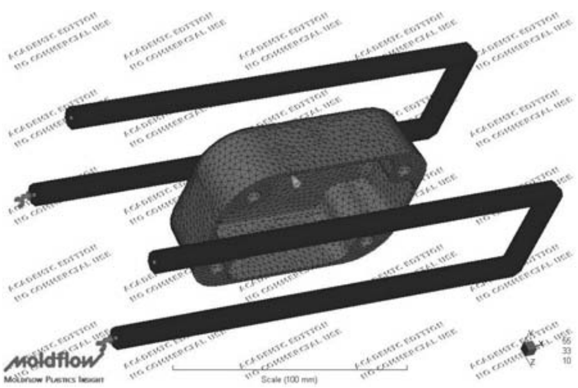
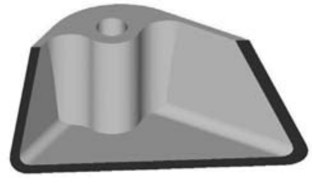
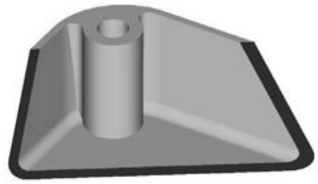


Fig. 2. FEM model of molded part

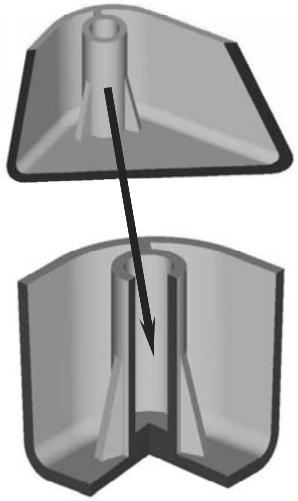
a) Model I



b) Model II



c) Model III



d) Model IV

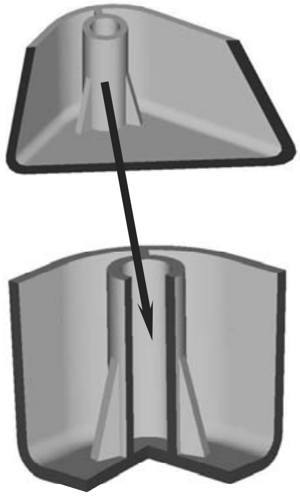


Fig. 3. Constructional details of molded parts used in investigations: a) initial construction, b) after radius of fillets changes, c) introduction of ribs, d) depth of hole change

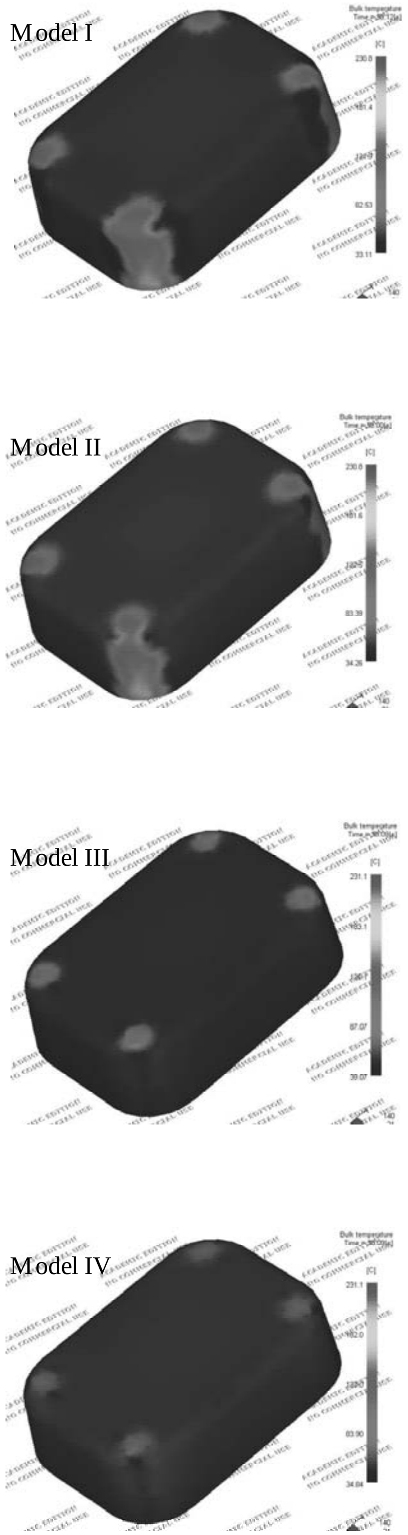


Fig. 4. Results of simulation investigations – bulk temperature distribution

In the Figure 1 solid (3D) model of molded part was presented. In the Figure 3 structural details which decide about part quality was presented. At first into simulation studies model from picture 3a was used. After accomplishing calculations and analysis of received results, structural changes were brought in model (changing method of connecting of sleeves with part body – Fig. 3b). Once more injection simulation was realized and was made the analysis of results. In next steps of model modification a ribs was applied – Fig. 3c, and holes in sleeves were deepened – Fig. 3d.

3. Results

Presented results apply to process carrying in following conditions:

- Flow rate - 20 cm^3/s,
- Max. Injection pressure – 800 bar,
- Injection time – 2.5 s,
- Cooling time – 10 s,
- Injection temperature - 240 ºC,
- Mold temperature - 25 ºC.

Simulation studies results were presented in Figure 4. All results were grouped, for making possible the comparison of particular structural results (four variants described above). Figure 4 is presenting distribution of molded part temperature in the moment of part removing form injection mold.

4. Conclusions

Simulation investigations results let us claim, that specialize computer programs make prediction of specific phenomena appearing for particular process possible. Modern simulation programs provide satisfying true image of reality [1-21].

It means that in product designing phase it is we can predict and optimal the generation process. Optimal results have confirmed the literature prediction and cases met in industrial practice.

To sum up it is proper to say, that application of professional computer programs to injection molding process make possible to eliminate series of structural errors during designing and introducing into production new composite materials.

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