WYBRANE PROBLEMY INŻYNIERSKIE
NUMER 2
INSTYTUT AUTOMATYZACJI PROCESÓW TECHNOLOGICZNYCH
I ZINTEGROWANYCH SYSTEMÓW WYTWARZANIA

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FLOW SIMULATION OF THE TWO-COMPONENT PLASTIC INJECTION PROCESS WITH REINFORCED PARTS

Abstract: This paper presents a simulation of two-component injection process for obtaining plastic parts with metallic reinforcement using a specific software package, MoldFlow. It will consider the following process parameters, mould temperature and injection pressure. The study will analyze the comparison between plastic parts with and without metallic reinforcement. It will highlight the differences that occur between the input parameters, mould temperature and injection pressure and the out parameters, cooling time and injection time for those types of parts obtained. Furthermore will be simulated a mechanical stresses of traction using a specific software package, Cosmos, for both parts obtained.

1. Introduction

The two-component injection process has many applications such as in automobile industry, computer industry and in different pieces for household use. The need to increase productivity and the evolution of the molding machine and mold processing technologies, has allowed injected two component parts to be made on the one machine in one operation. To realize the two-component injection process the injection machine with two injection cylinders were made, and weaknesses related to network injection system was removed by creating heated channels.

The two-component injection process could be classified as followed:

-color injection is the classic two-component injection with two horizontal injection cylinders and automated transport system;

-color injection with one vertical cylinder and the other one horizontal;

-mixed injection where the cylinders are horizontal and parallel and the material comes up from both injection cylinders [1].

This paper will analyze the comparison between plastic parts with and without metallic reinforcement. It will highlight the differences that occur between the input parameters, mould temperature and injection pressure and the out parameters, cooling time and injection time for those types of parts obtained.

Most important factor of injection process is the cooling time and that occurs after the mold is opened, the cooling operation continues. In plastic injection cycle, the cooling times are the longest, getting up to 68% of the total period of the process [2].

The injection technology aims to obtaining the shortest cooling time possible that assures the prescribed quality of the piece.

The figure 1 presents the temperature variation inside a plastic component during the cooling operation.

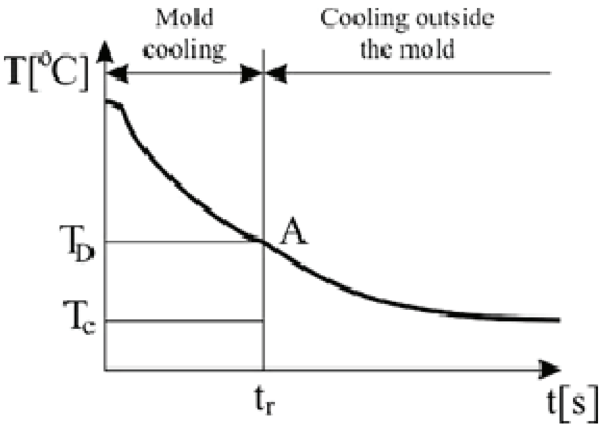


Fig. 1. Temperature variation inside a plastic piece during cooling operation; Tc – environmental temperature, TD – mold release temperature; Tr – cooling temperature.[2]

Furthermore will be simulated a mechanical stresses of traction to analyze the comparison study between those types of parts obtained.

2. PREPARING THE SIMULATION PROCESS. RESULTS AND DISCUSSIONS.

2.1 Flow Simulation

The material used during the simulation is ABS and metallic reinforcement. The pieces used for study is presented in figure 2 and figure 3. The 3d models are realized using the SolidWorks2011 software package and for the flow simulation will use MoldFlow Software package.

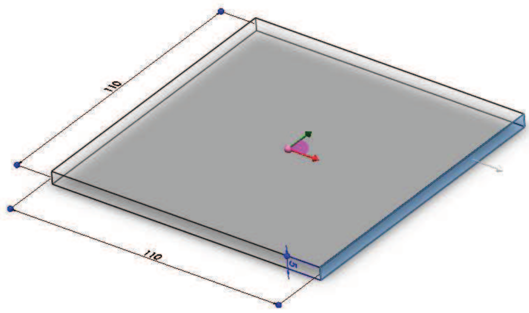


Fig. 2. Part without metallic reinforcement

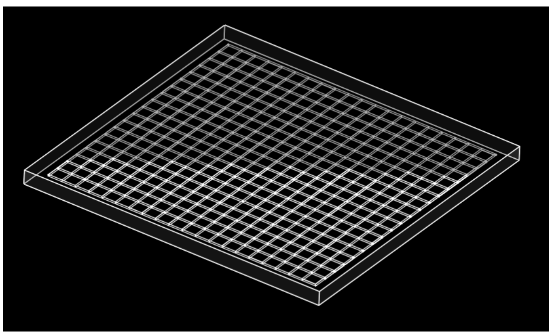


Fig. 3. Part with metallic reinforcement

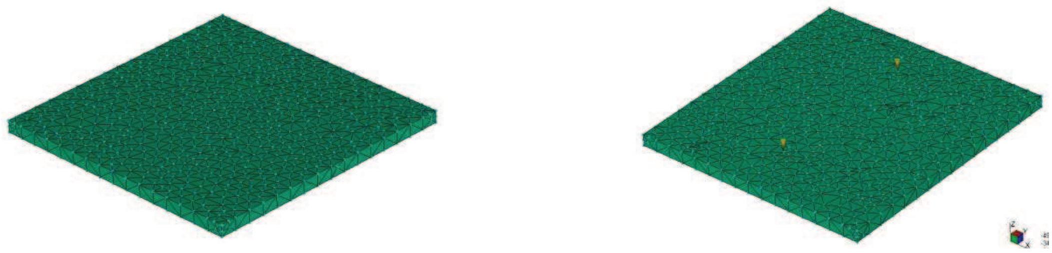
Initial data on which the injection process will be studied are:

Machine parameters:
Maximum injection pressure: = 1.8000E+02 MPa
Maximum machine clamp force: = 7.0002E+03 Mg
Maximum machine injection rate: = 5.0000E+03 cm^3/s
Machine hydraulic response time: = 1.0000E-02 s
Temperature control:
Melt temperature: = 265.00 °C
Mold temperature: = 75.00 °C
Mold-melt heat transfer coefficients
Global values. (Superseded by any values set on individual elements.)
Filling = 5000.0000 W/m^2-C
Packing = 2500.0000 W/m^2-C
Detached = 1250.0000 W/m^2-C
Atmospheric temperature = 25.00 C

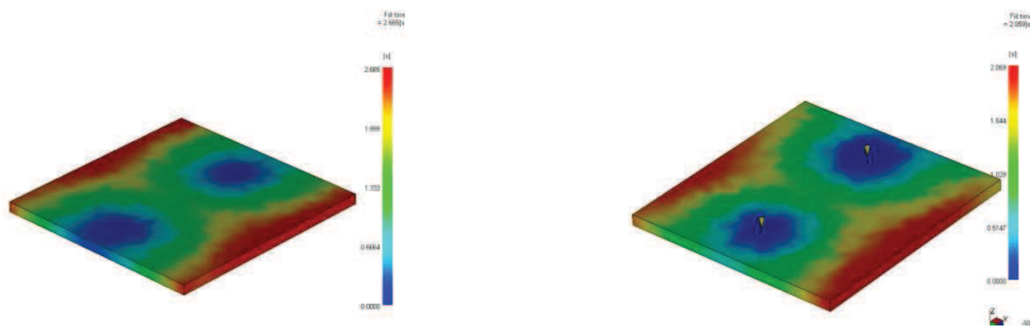
2.2 Flow simulation results

Following the injection process flow simulation were obtained the following results:

Part without metallic reinforcement | Part with metallic reinforcement



Mesh

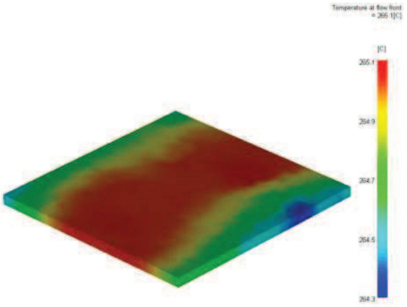


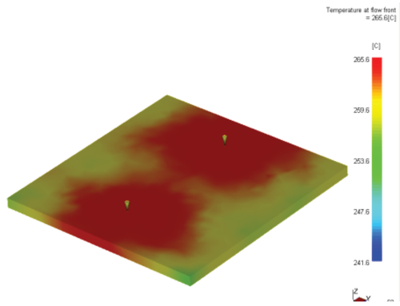
Fill time

Part without metallic reinforcement	Part with metallic reinforcement
Filling phase results:	Filling phase results:
Current time from start of cycle = 2.6655 s	Current time from start of cycle = 2.0588 s
Total mass = 62.3716 g	Total mass = 59.5356 g
Frozen volume = 7.0531%	Frozen volume = 6.3324%
Injection pressure = 2.3491 MPa	Injection pressure = 8.3458 MPa
Volumetric shrinkage-minimum=3.6397%	Volumetric shrinkage- minimum=2.3744%
Volumetric shrinkage-maximum=11.180%	Volumetric shrinkage- maximum=12.269%
Time at velocity/pressure switch-over =2.6621s	Time at velocity/pressure switch-over =2.0508s

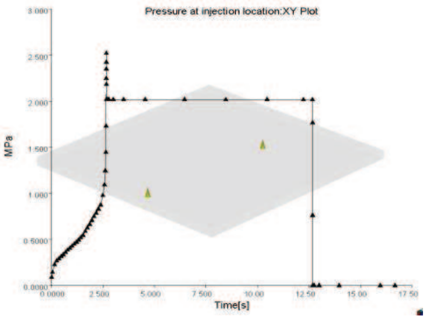
Injection pressure at velocity/pressure switch-over= 2.5212 MPa
Volume filled at velocity/pressure switch-over = 99.8892%

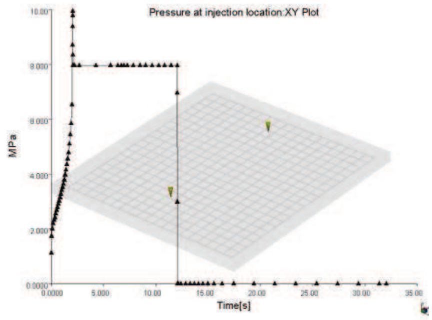
Injection pressure at velocity/pressure switch-over= 9.9412 MPa
Volume filled at velocity/pressure switch-over = 99.6503%



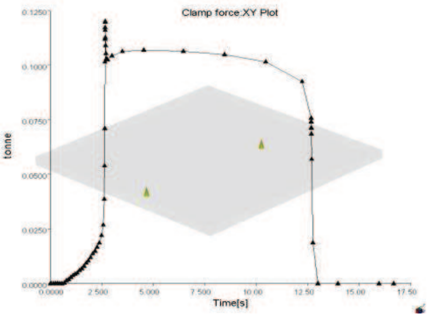


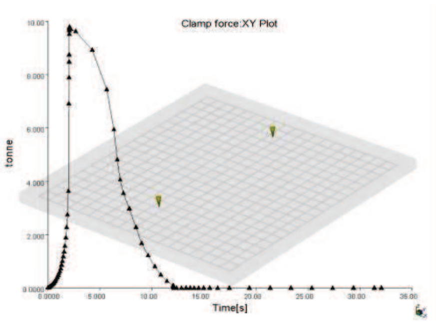
Temperature at flow front





Variation of injection pressure

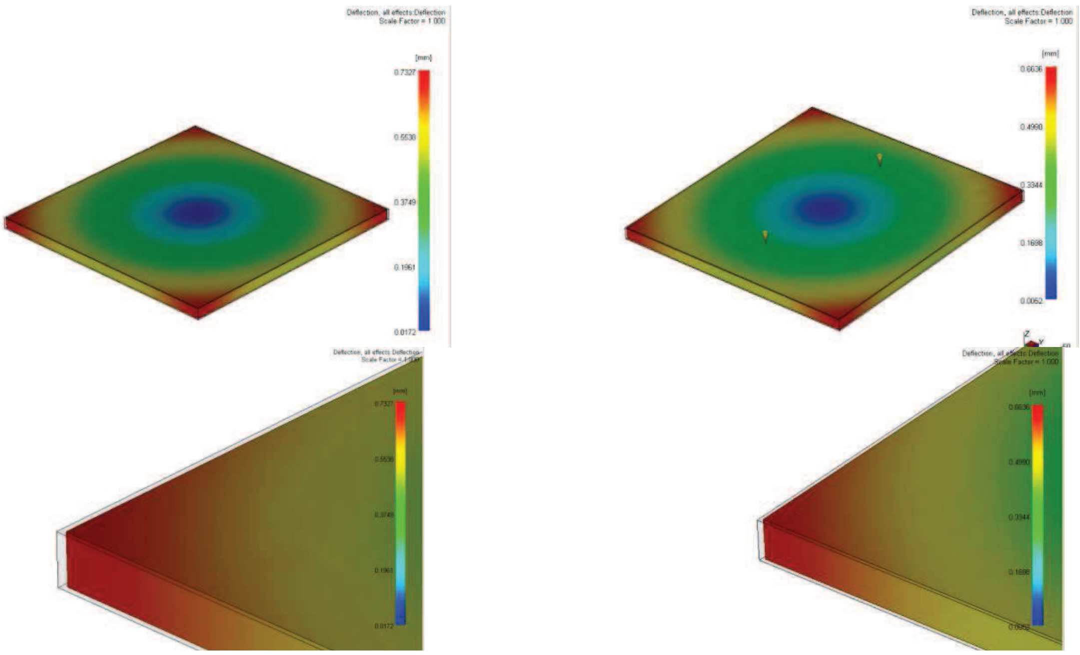




Variation of clamping force

Packing phase results summary:
Current time from start of cycle = 16.6621 s
Total mass = 64.2527 g
Frozen volume = 32.1140 %
Injection pressure = 0.0000 MPa
Volumetric shrinkage - minimum = 3.6397%
Volumetric shrinkage - maximum = 11.1809%
Maximum velocity = 0.9901 cm/s
Maximum shear rate = 346.4222 1/s

Packing phase results summary:
Current time from start of cycle = 32.0508 s
Total mass = 62.3522 g
Frozen volume = 100.0000 %
Injection pressure = 0.0000 MPa
Volumetric shrinkage - minimum = 2.3744%
Volumetric shrinkage - maximum = 12.2696%
Maximum velocity = 9.2277 cm/s
Maximum shear rate = 5926.1172 1/s



Warp deflection X,Y,Z

Minimum/maximum displacements at last step (unit: mm):

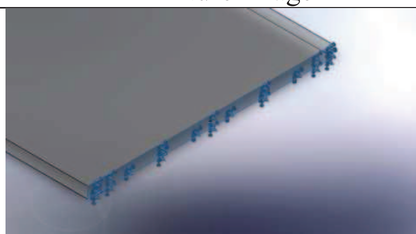
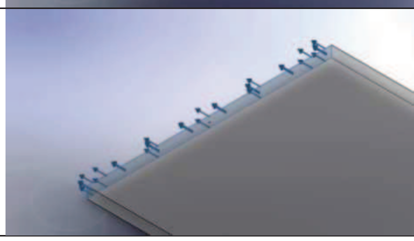
	Min.	Max.
Trans-X	-7.2657e-03	1.0377e+00
Trans-Y	-2.9667e-03	5.3170e-02
Trans-Z	-9.7771e-03	1.0381e+00

Minimum/maximum displacements at last step (unit: mm):

	Min.	Max.
Trans-X	-1.0769e-02	9.1734e-01
Trans-Y	-2.3517e-02	9.8747e-01
Trans-Z	-7.3720e-02	4.3363e-02

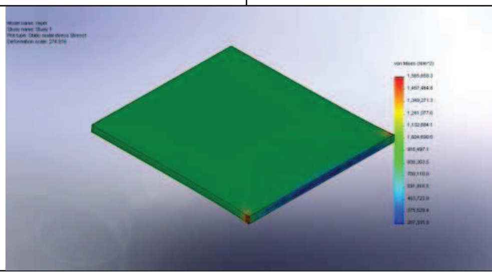
2.3. Mechanical simulation

The simulation of mechanical stresses of traction is made in Cosmos software package and the initial data are:

Fixture name	Fixture Image	Fixture Details
Fixed-1		Entities: 1 face(s) Type: Fixed Geometry
Force-1		Entities: 1 face(s) Type: Apply normal force Value: -50 kgf

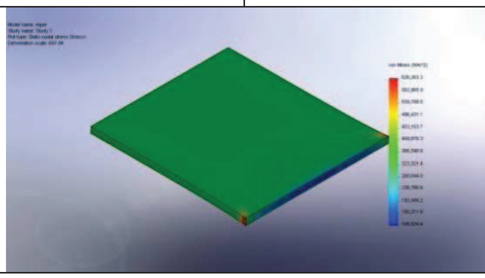
2.3.a. Part without metallic reinforcement – obtained results

Name	Type	Min	Max
Stress1	VON: von Mises Stress	267336 N/m^2 Node: 303	1.56566e+006 N/m^2 Node: 7



2.3.b. Part with metallic reinforcement – obtained results

Name	Type	Min	Max
Stress1	VON: von Mises Stress	106934 N/m^2 Node: 420	626263 N/m^2 Node: 43



3. Conclusions

After the experimental research the main conclusions are as follow:
- This comparative study reveals that for parts with metallic reinforcement the injection time is less because its pressure is much greater than the parts without metallic reinforcement;
- We can see a time when growth is achieved packing phase for the parts with metallic reinforcement which leads to an increase in injection time;
- About warp deflection phase, the parts with metallic reinforcement have a less displacements comparative with parts without metallic reinforcement;
- The mechanical simulations highlighting the advantage of minimum displacement for the parts with metallic reinforcement and great mechanical resistance.

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