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3D MODELING PROGRAMS BENEFITS OF SIMULATION OF FILLING PROCESS IN THERMOPLASTIC MATERIALS INJECTION MOLDS

Ştefan Mihăilă, Radu Gheorghe Mărieş
University of Oradea, România
mihailasna@yahoo.com

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Abstract

This work tries to emphasis the necessity of using computer based simulation programs in all the activities fields, producing high and very high complexity of plastic mass and where the manufacturing series are very large.

Also, the work presents the steps which are necessary to be in practice in order to obtain all the necessary dates in realizing high quality products which can be obtain in a short time and reduction in price in order to be successful on the world market.

1. Introduction

Given that many products of thermoplastics have very complex shapes, shapes which sometimes create special problems both on material flow and in the execution time of the mold, the mold filling process simulation in most cases becomes a necessity.

Simulations can be performed using 3D programs, programs that are made by different companies specializing in this field.

In this paper, I will present a case study on using the preform injection of different flows and analysis based on the values of parameters such as filling time, injection speed and cooling time, 3D simulation being performed in program called Moldflow. [4].

2. Overview of the program. Case Study.

This program uses a "mesch" (net) geometrical model that is created automatically by the program upon geometrical analysis of the piece.(Fig. 1).

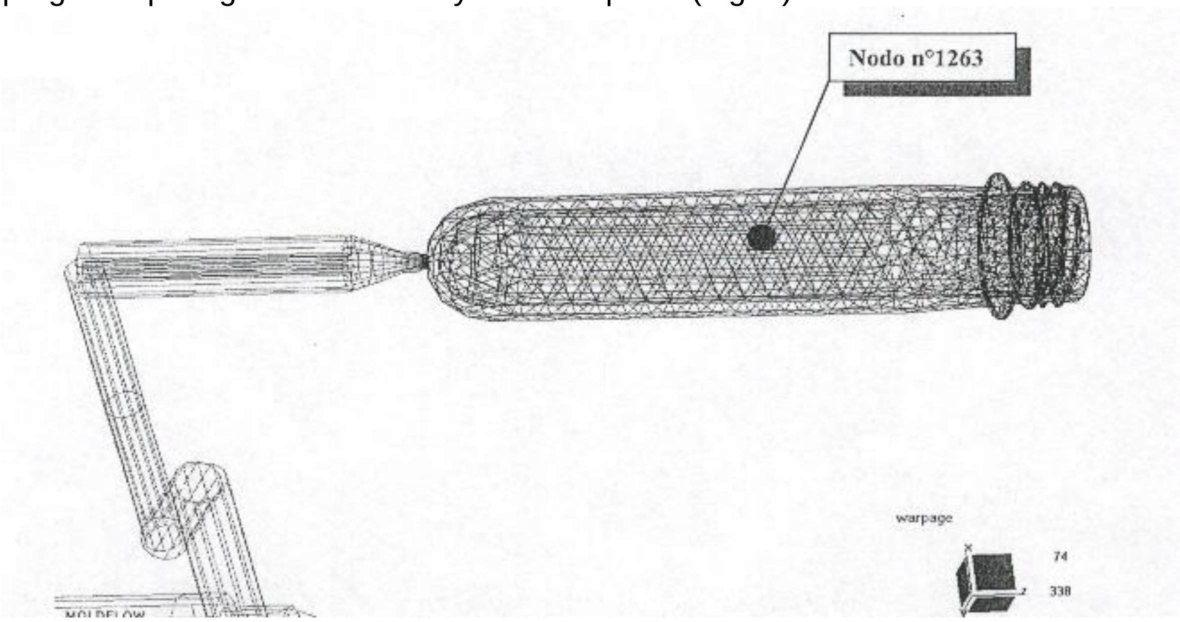


Fig.1. Geometrical model, created by the program, using the geometry of the piece that is subjected to analysis

The piece can be modeled in any three-dimensional computer simulation program and after that is imported as a IGES surface into the Moldflow analysis program. The "Mesch" contains triangular elements with three nodes, and flow simulation is based on the calculations in each node. Total number of node elements determine the accuracy of the results and duration of the analysis, several factors meaning greater precision, but also a longer computing time. Each node of the finite element of the "mesch" has an associated volume, and the sum of these volumes gives the model volume. [6].

The program also shows the best areas for the location of the injection point when the option "best injection gate location" is used. If not, the simulation will be selected for a random position, chosen by us, regarding some criteria of construction and operation of the mold, the aspect of the injected piece,or depending on the location of nests when we have a mold with multiple nests.

The next step is the choice of bank plastic materials according to program quality requirements imposed on injection part. Bank material is updated regularly and provide all necessary data of the calculation, as are data on the crystalline nature of the material, the material family of which it belongs, flow index, data relating to process conditions such as maximum and minimum temperature of the melt (and suggested temperature), as well as mold temperature, the maximum shear stress and shear speed. Material conductivity is also given, specific heat, the mold discard temperature and no flow temperature at which the front of material freezes.

Injection parameters can be based on the results of the calculation of their values or set values can be entered by the user. Values should be introduced for the injection temperature and profile pressure.

Using this program cooling simulations and residual stress calculations can be made. After calculations , isovalue diagrams are made, and they are to be analyzed and interpreted to see whether or not it is necessary to modify the parameters introduced as initial data to obtain high-quality molded parts.

Isovalue charts provide an accurate picture of areas where ventilation of the nest is necessary , shows the front flow position that occurs during the filling process, temperature and pressure values at any time of the injection process in all areas of play. Calculate the required clamping force and maintaining force during injection, which is supplied by the injection machine.

The Moldflow program uses design principles underlying the process of filling such as:

-Constant-filling flow on all routes with the same pressure and at the same time.

The filling process can be improved by changing the injection point, or the injection wall thickness in certain areas of the piece or by their combination.

-Pressure-gradient to be constant throughout the flow path length;

-Weld-lines are located in less sensitive areas;

-Shear-stress have lower values than the critical value;

-Dam-position is as far from where the flow front splits into thick and thin flows;

-Flow-network design so that the dam freezes after the filling and proper compaction, a phenomenon that leads to the elimination of overcompacting that could cause internal tensions in the piece;

-Cooling time should be as uniform as possible in all nodes as low as possible.

The Moldflow program can automatically perform many diagrams which make the analysis process [6]..

3. Case Study

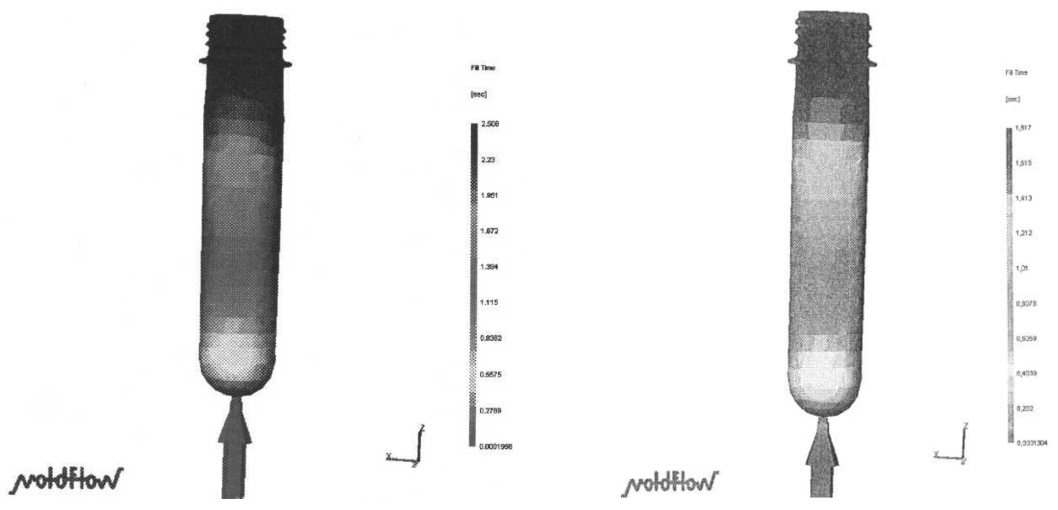
Furthermore, this paper will present a couple of experiments, conducted on a PPS 20000 material, used in preform building, and analizing the piece obtaining time, relative to it's size. The program used here si MOLDFLOW. With this program simulations have been made to four preform tipes while usiing a flow rate of 600, 900, 1100 and 1500 cm3 / s, while checking the five parameters that are considered among the most important, namely: filling time, injection speed, time of compaction, closing time and cooling time.

The simulation graphs presented below (Fig. 2 and 3) shows that the filling time varies depending upon flow rate, respectively as the flow is higher the filling time is lower. In Table 1 also shows the rest of the values like injection speed, which increases with the size of the flow during cooling and it is proportional to the flow regardless of the cooling system design. The simulation also shows that both the compaction time and mold closing time is a constant, regardless of flow rate size.

Simulations made clear that for the four types of preform, despite having different sizes when having identical shapes, time of production is virtually constant, so the size of the nest does not influence significantly the completion time of the piece.

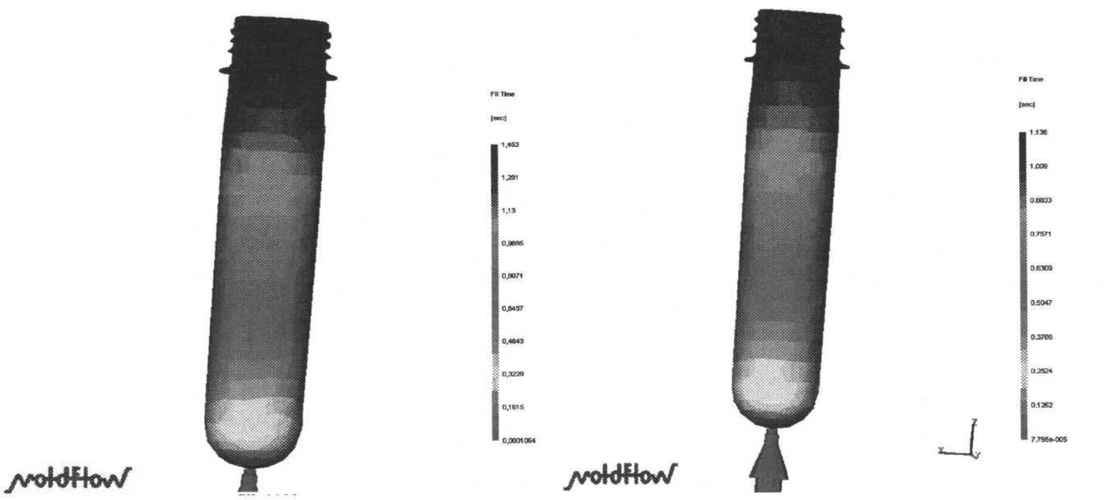
Table 1. Representation of time filling compaction, cooling and injection velocity of the flow rate depending on the polymer.

Flow nominal PPS 20000 [m^3/s]	Filling time [s]	Injection speed [g/s]	Compaction time [s]	Cooling time [s]
600	2,664	10,9	4,4	1,036
900	1,833	15,9	4,4	1,867
1100	1,545	18,9	4,4	2,155
1500	1,142	25,6	4,4	2,558



a ***b***

Fig.2 Mold filling diagram
a-nominal flow rate of 600 cm3 / s, b-nominal flow rate of 900 cm3 / s



a **b**

Fig.2 Mold filling diagram
a-nominal flow rate of 1100 cm3 / s, b-flow rate of 1500 cm3 / s

Conclusions

The obtained results show that the time of completion of a injected piece isn't proportional to it's size, and that it is influenced by a lot of factors which don't always seem important, like the quality of thenest surface, which cannot be determined using the computer, the thermal conductivity of the active part of the mold and othere elements that cannot be anticipated by the program. All in all, the mold injection computer-based simulation is becoming a necessity for complex pieces as well as in large scale fabrication, judging by the advantages shown here, although the acquisition price is relatively high.

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