MONITORED MOLD AND INJECTION MOLDING SIMULATION PARAMETERS COMPARATION

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Abstract: The main objective of the present work is to identify the exact of behavior of ABS when it is injected into a mold. We study the conditions and the most important parameters of the process, emphasizing the injection pressure and cycle time. Another objective is to characterize two of the properties of the material that most influence the injection of thermoplastic materials. For the calculation of viscosity, a capillary rheometer was used, and a Differential Scanning Calorimetry (DSC) was used to determinate specific heat capacity. The final objective of the work is to quantify the accuracy of the data obtained by a computer aided simulation to help determine the best processing conditions. To this end, results obtained from this simulation and results obtained from a mold monitored with sensors were compared. Finally, the possible causes of the differences observed in this comparison are presented.

1. INTRODUCTION.

The injection molding process of thermoplastic materials is an important process in the manufacture of a lot of products. There is currently a lot of research, such as that of doctor M.J. Reig [1-2], into the effect of recycled material on the parameters in the Injection Molding Process. The studies on recycled ABS carried out by the doctors R. Balart, D. García [5-3] show that we can improve the resistant characteristics with small contributions of PC. Therefore, the study of the process conditions of ABS starting from recycled materials is of certain interest.
Also of interest is the comparison of process variables obtained by a simulation with process variables obtained from a mold and determining the differences between both, to be able to model the real behavior of this material. The characterization of materials [6-10] is also an area where more work is needed to refine the results.

2. EXPERIMENTAL

For the development of this study a mold was manufactured (Fig. 1b) which was designed to be able to inject two types of piece (Fig. 1a).
The software used to study the simulation of the fluid inside the cavity, is the "Plastics Insight 6.1 of Moldflow"® (Fig. 1c).
To contrast the results of the simulation, some pieces have been injected in the mold (equipped with five sensor Transducer KLISTER® 6190A0.8) in an injection molding machine "Meteor 270/75 of Mateu & Solé®", using the program of treatment of signs, "Dasylab ®".

For the development of this study virgin ABS (Polidux A_164 of Repsol IPF®) has been used.

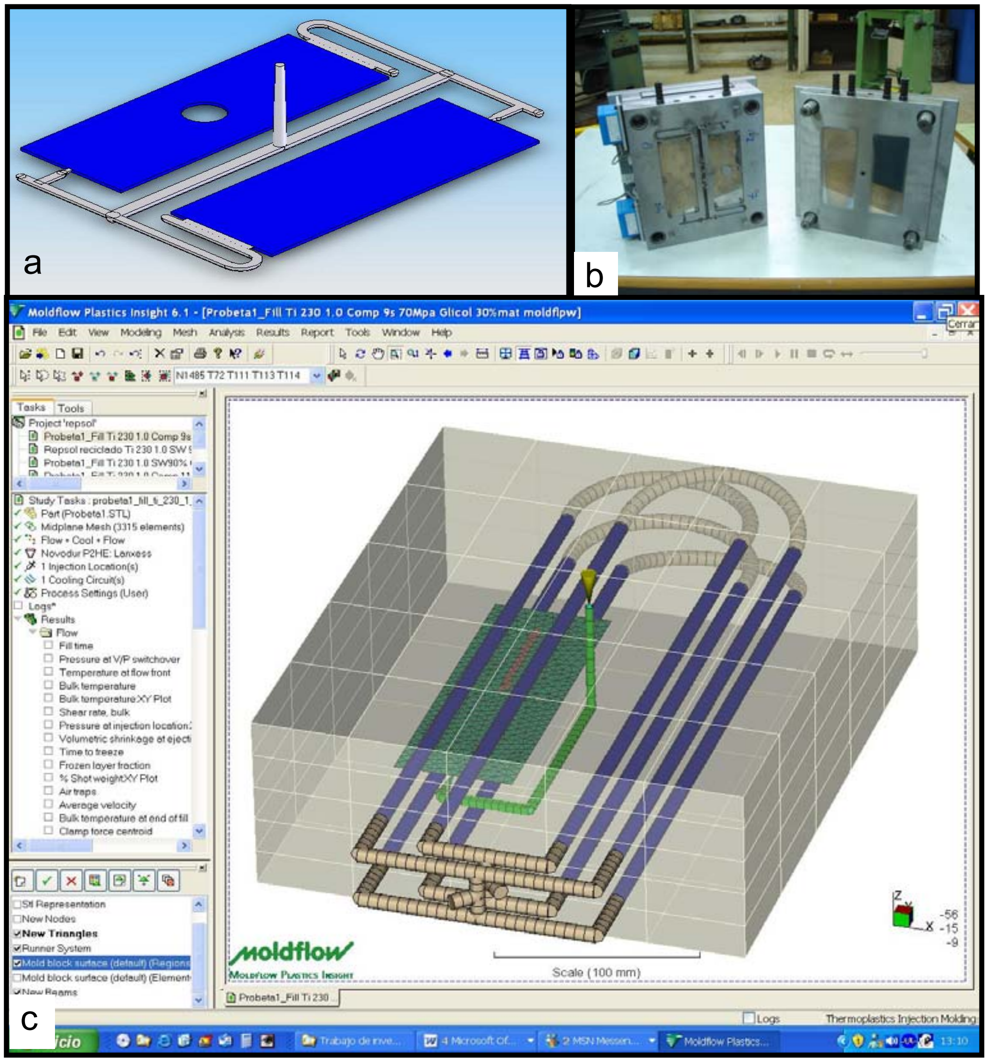

Figure 1. Scheme of the injected piece. Injection mold. Simulation program.

3. RESULTS AND DISCUSSION

Simulation

By means of program "Insight 6.1" we carried out several simulations at different times of injection. Optimum process conditions were obtained, obtaining the graphs of injection pressure and cycle time and the graph of temperatures in the injection point.

The result of the simulation is reflected in figure 2a and 2b. In this figure, the graphic pressure-cycle time and the graph of temperatures in the injection point can be observed. Here we can observe in a period of time of 10 seconds (corresponding to a packing of 9 seconds) the temperature of the injection point is below the 100ºC (glass transition temperature) and therefore, the material can not be compacted further. It is also observed that, at about 14 seconds, the piece is also below 90ºC (expulsion temperature) and the piece can be extracted.

A batch o piece was injected with material producing the following graph of pressure-time starting from the capture of the data of four injections with the stabilized machine. Fig 2c.

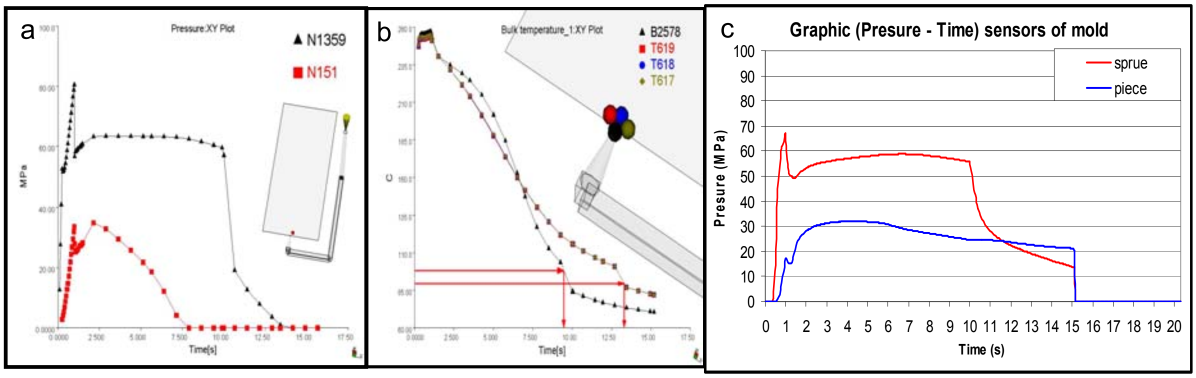

Figure 2. Graphs obtained with data software.

Characterization of the material

a) The specific heat capacity:

The data of specific heat capacity, in the simulator database, has a approximate value in this case of 1800 J/(kg ºC) for 240 ºC. After calculation, the graph of figure 3 was obtained, which was introduced in the simulator. For the temperature of 240 ºC the value of Cp is 2716 J/(kg ºC), that is to say, a difference of 50% more. Another consequence of the calculation is that we obtained the glass transition temperature. In this case of 105 ºC which substitutes the 100 ºC that appeared in the database of the simulator.

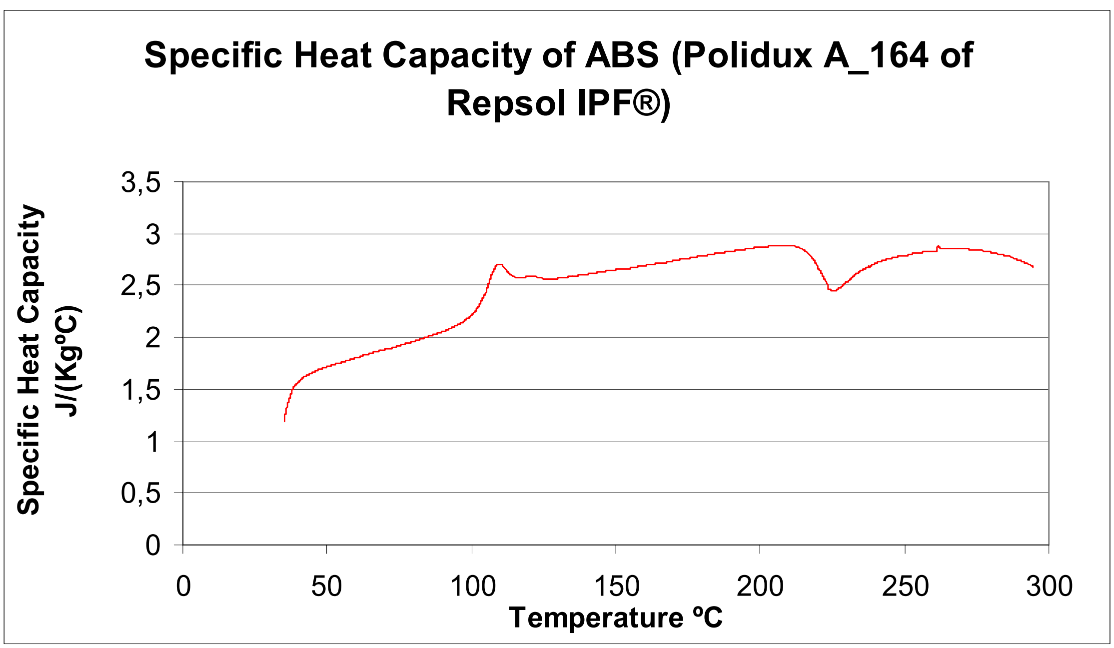

Figure 3. Cp ABS (Polidux A_164 of Repsol)

b) Viscosity:

The capillary rheometer "Rheoflixer MT®" was used, following the Norm ISO 11443: 1995. In figure 4, we can observe the graphic representation of the viscosity with the data of the simulator and with the data calculated. The difference is 29%.

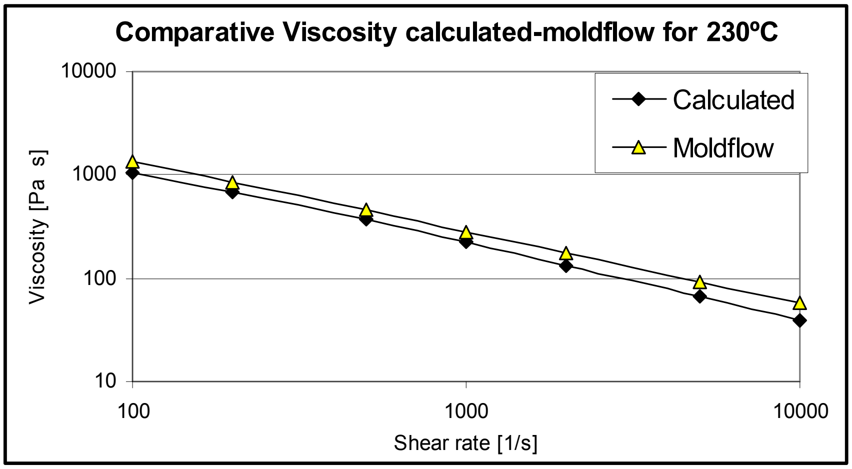

Figure 4. Graph of viscosity for 230ºC

c) Thermal conductivity:

The value that the simulator offers, 0,127 W/(m ºC), was contrasted with others looked for in the bibliography 0,17 W/(m ºC). The difference between the data simulator and the data used is 33%.

Second Simulation

After simulation with all the new data the graph of pressures of figure 5 left is obtained. In figure 5 center we can see that the packing time should not be superior to 11 seconds and that the cooling time doesn't need to exceed 3 seconds. We injected another batch of pieces using the last data of the simulator, in order to obtain the pressure-time graphic (Fig. 5 right).

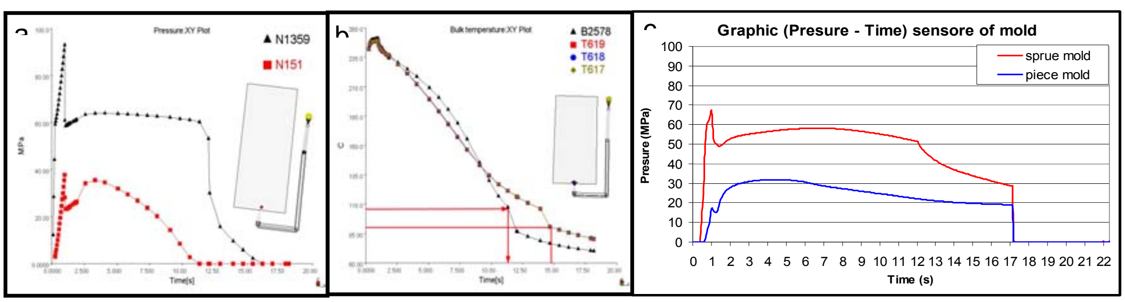

Figure 5. Graphs obtained with data calculated.

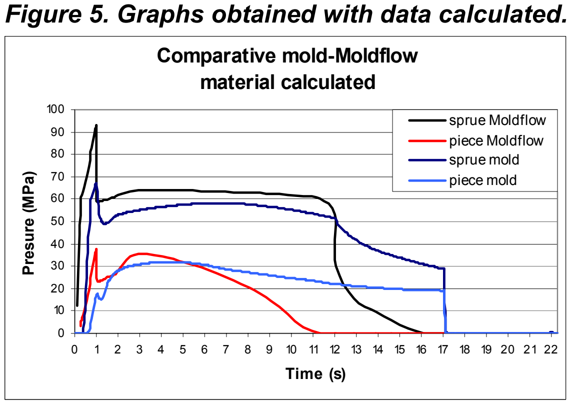

Figure 6. Comparative mold graphic - Moldflow graphic

4. CONCLUSIONS.

For the study of the conditions and parameters in ABS injection process simulators provides are a good tool. An error of 10% is calculated between the data that the simulator provides and those obtained by the sensors of the mold figure 6.
With the use of a single pressure sensor in the base of the sprue in the molds and the use of the simulators you can extrapolate the real pressure in any part of the piece, with the rising economic saving in the use of sensors in the molds.
There is a need for characterization of materials, since, the values obtained in the databases are not exact and they differ greatly from those calculated. A difference of 50% is appreciated in the specific heat capacity, of 29% in the viscosity and of 33% in the thermal conductivity. These differences, although very big, are compensated and cause the cycle time to differ 10% between the data obtained in the databases and those calculated.

5. REFERENCES

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