Measurement 46 (2013) 3488–3493

Contents lists available at SciVerse ScienceDirect

Measurement

journal homepage: www.elsevier.com/locate/measurement

Comparative analysis of polyolefins and polycarbonate rheological behavior when they are injected over fabric

A. Martinez *, J. Fuentelsaz [1], E. Sanchez [1], J. Aisa [1]

TIIP – Zaragoza University, C/Maria de Luna 3, Edif Torres Quevedo, 50018 Zaragoza, Spain

ARTICLE INFO

Article history:
Received 20 February 2013
Received in revised form 20 June 2013
Accepted 26 June 2013
Available online 4 July 2013

Keywords:
Injection
IMD
Polycarbonate
Polypropylene
Spiral mould measurement

ABSTRACT

In mould decoration or injection moulding over fabric is a plastic transformation process to produce upholstered complex parts introducing a tissue of textile inside the mould during the moulding cycle.

One of the most reliable ways to optimize injection cycle is to use simulation software, but in case of recognized software, the simulation of IMD process is not possible because the behavior of the polymer flowing over fabric is unknown. Some research work about injecting polyolefines over fabric exists, but authors have not found any comparative study in which plastics with high viscosity are injected over textile.

This paper shows some measurement results, and it is focused on comparing the differences between viscosity of polypropylene and polycarbonate when they are injected by means of conventional injection process, and when they are injected over fabric. The main aim is to understand how the viscosity curves vary when the fabric intervenes during the injection cycle, and how much the textile affects when high viscosity polymer is injected over this textile. These measurement results have been obtained using a spiral mould.

1. Introduction

Injection moulding is one of the most popular methods to produce complex plastic parts, especially when large series are required. First, the polymer is heated and melts (melt temperature depends on plastic type). After this, it is pushed into the mould using high pressure (filling and packing phases). After a time to cool down the material due to coolant flow (usually water), the mould is opened and the part is ejected. Ideally, the parts will be finished without any additional work.

Mainly, in the automotive industry, it is very important the aesthetic aspect of parts inside the car. Plastic films or textile can be overmoulded, to get a new appearance. This is the IMD process (In Mould Decoration), which is one of the most efficient and cost-effective way to decorate a part during the moulding cycle (Fig. 1).

Nowadays the company's goal is to produce this type of parts, minimizing its costs. The way to get that is minimizing each piece time production, that it is to say, reducing decorated parts injection cycle. If this superficial aspect can be obtained during the moulding process, production time and material needs can be reduced [1–8].

One of the most important tools for a good design, for an efficient manufacture of the piece and its corresponding mould, is simulation software adequate to predict the molten plastic flow advance inside the mould. Nowadays, software does not have potential to simulate IMD process, because the behavior of the polymer flowing over fabric is unknown.

For a right simulation of injected parts, it is necessary to characterize polymer rheological behavior. Several rheological models are used to calculate pressure drops, when molten plastic flows into the mould [9–11]. Often these models are introduced in programs like C-MOLD, TM Concept and MOLDFLOW to make calculations. The rheological

* Corresponding author. Tel.: +34 976 76 19 70; fax: +34 976 76 19 69.
E-mail addresses: arantza@unizar.es, arantzamartinez@hotmail.com (A. Martinez), jesus.fuentelsaz@unizar.es (J. Fuentelsaz), esg@unizar.es (E. Sanchez), jorge.aisa@unizar.es (J. Aisa).
[1] Tel.: +34 976 76 19 70; fax: +34 976 76 19 69.

0263-2241/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.measurement.2013.06.047

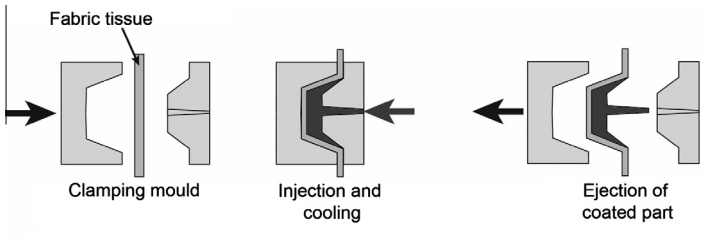

Fig. 1. Injection over fabric scheme.

curves of plastic material flowing over a metallic surface are provided by the raw material manufacturers, and these curves can be obtained using different types of viscosimeters, but the behavior of plastic flowing over fabric is not known because it is not possible to introduce textile into a viscosimeter or a rheometer.

During the five last years, some authors have been studying IMD process which uses decorated film [12–16], but they analyze the influence of film on plastic temperature inside the mould and not study the influence of this film on the manner of flowing and on injection pressure. Besides, there are no references to this kind of studies when fabric instead of film is used.

On the other hand, during the last four decades, several investigations have been carried out using a spiral mould to analyze viscosity, and to obtain a prediction of flow length and pressure drops [17–24], but anyone does not study the possibility to use the spiral mould to investigate the IMD process, and the influence of the film or fabric on the injection pressure.

During last year, authors of this article have begun a research work in which spiral mould and injection over fabric measurements are combined, but the study only reaches the analysis of polyolefines injected over textile. Polyolefines are polymers with low or medium viscosity values having little difficulty on flowing over textile, and therefore it has no knowledge of which are the consequences of injecting a high viscous polymer on fabric by IMD technique [25,26].

This paper shows some measurement results, and it is focused on comparing the differences between viscosity of polypropylene and polycarbonate when they are injected by means of conventional injection process, and when they are injected over fabric. The main aim is to understand how the viscosity curves vary when the fabric intervenes during the injection cycle, and how much the textile affects when high viscosity polymer is injected over this textile.

2. Equipment required

The material required to get the goals described above includes a spiral mould with two pressure transducers, a recording pressure system, one fabric frame, and one type of tissues of fabric as well as raw material and the injection machine.

The SPIRAL mould is a mould with a spiral figure 136 cm long and it has a 20×2 mm rectangular section (Fig. 2).

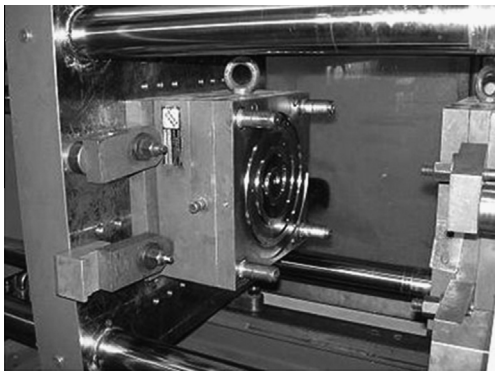

Fig. 2. Spiral mould.

Two pressure transducers are located into the spiral mould, to 60 mm and 144 mm far from the spiral mould gate. These transducers are KISTLER 6157BBSP0 quartz sensors. Its main characteristics are a temperature range for the mould up to 300 °C, a temperature range of molten material in front of the sensor up to 450 °C, a pressure range up to 2000 bar, sensitivity of −4pC/bar and natural frequency up 100 Hz.

To complete the measurement system, the sensors are connected to a PC through an amplifier and converter set. This device captures the transducers signal and it will be converted into numerical data by the computer. When molten plastic reaches a transducer, this one begins to register pressure values.

In case to introduce fabric into the mould, it is necessary a fabric frame which is attached to the cavity of the spiral mould and used to hold the textile (Fig. 3). This tensor is completely fitted to the mould and has four tweezers to clip the fabric. Then, the fabric is always fastened in the same way and there is never a gap between fabric and mould surface.

To inject spirals, the injection machine used is a Mateu & Sole hydraulic clamping machine, which is appropriate for the spiral mould size. Its main characteristics are a clamping force of 55Tn, a plastification capacity of 50 g/s, a mould thickness between 120 and 300 mm and a maximum injection pressure of 1735 bar.

All the spirals are injected with a polycarbonate Iupilon H3000 and polypropylene Stamylan PHC 31.

The fabric used for this study is FALSET which is composed of three layers. The first one gives the aesthetic to