POLISH ACADEMY OF SCIENCES - COMMITTEE OF MATERIALS SCIENCE
SILESIAN UNIVERSITY OF TECHNOLOGY OF GLIWICE
INSTITUTE OF ENGINEERING MATERIALS AND BIOMATERIALS
ASSOCIATION OF ALUMNI OF SILESIAN UNIVERSITY OF TECHNOLOGY

Conference Proceedings

12th INTERNATIONAL SCIENTIFIC CONFERENCE
ACHIEVEMENTS IN MECHANICAL & MATERIALS ENGINEERING

Crystalinity degree change for mouldings and its influence on quality at extreme parameters of injection

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Empirical research results concerning influence of injection moulding parameters on distribution of crystalinity degree on injection moulding piece.

1. INTRODUCTION

During multimolecular polymers processing for precision, motor and medical industry i.e. wherever quality and dimensional accuracy high-level demands of product are being made, very important thing is, undoubtedly, apart from cleanliness and high quality of output plastic itself, controlled conducting and familiarizing with the injection process, and, to be exact, phenomena which they are described with and which occur during the process. Received results have been presented in the form of graphs of crystallization degree dependence on selected technological parameters, mainly cooling time, mould temperature and holding pressure [1, 2, 3, 4, 7].

2. EXPERIMENT PREPARATION

Polyoxymethylene POM (SANITAL) M8 from group of partly crystalline polymers has been used for research. This is one of constructional materials commonly used in different types of precision mechanisms parts. It is characterized by large abrasion/high temperature resistance and low water absorbing capacity.

2.1. Moulded piece and measurement diagram

View of arrangement of measurements points and pressure sensor of moulding was presented on figure 1.

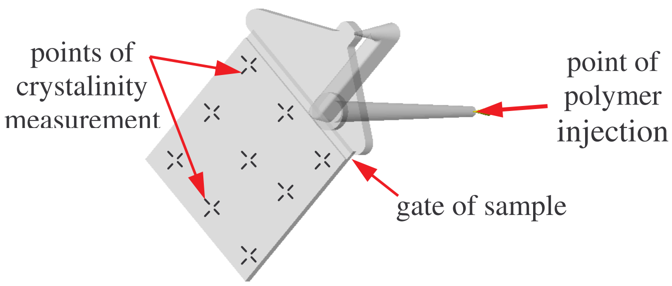

Figure 1. Moulded piece diagram, arrangement of measurements points

3. OPERATING CONDITIONS

Range of parameters assumed for experiments is shown in table 1.

Table 1 – Operating conditions

No.	Parameter, symbol	Unit	Polyoxymethylene POM	
			low value	high value
1.	Mould temperature, T_{for}	deg. C	30	70
2.	Polymer temperature, T_{tw}	deg. C	175	210
3.	Cooling time, $t_{chł}$	s	10	56
4.	Holding pressure, p_{doc}	MPa	30	60
5.	Injection velocity, v	mm/s	20	120
6.	Filling time, t_{wt}	s	Calculated from graph for pressure of plastic which flow inside the mould	

4. ANALYSIS OF RESEARCH RESULTS

4.1. The results of computer simulation of filling stage

During the research the computer simulation of filling stage of injection mould were conducted. The results were presented in fig. 2a, b.

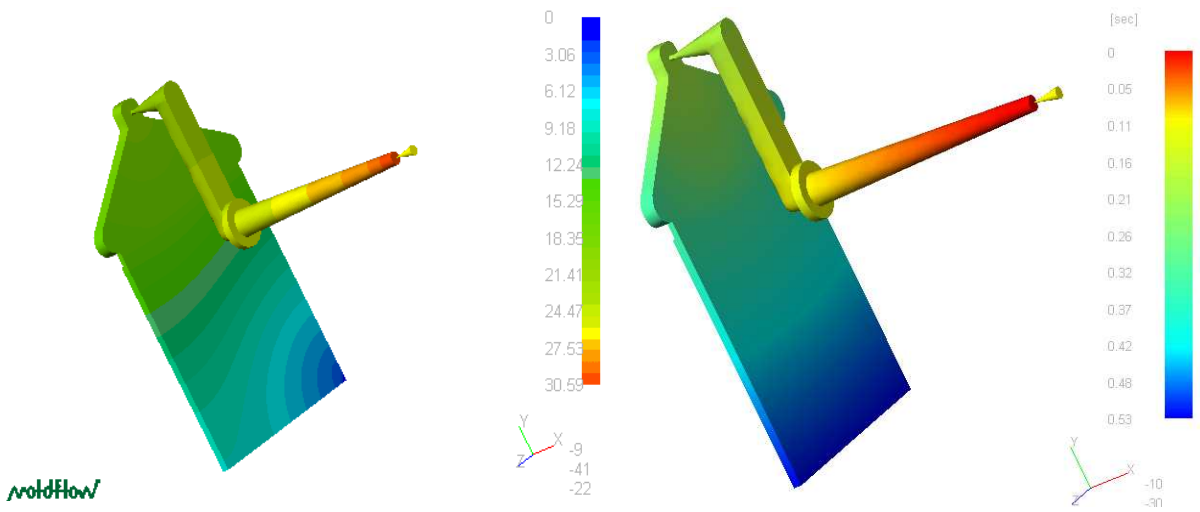

Figure 2. Results of computer simulations injection molding: a) distribution of injection pressure, b) flow front and filling stage

The pressure distribution on the moulding (on the left bottom corner we can see the decrease of pressure) is not symmetrical although the front flow of polymer is symmetrical to the axis of moulding. Analyzing below-shown images of temperature distribution on the surface of the moulding we can assume that one part of the moulding is cooling faster. It is connected with faster solidification of polymer and with lower pressure of polymer in the mould.

4.2. The results of the moulding cooling observed with the use of thermovision camera

We can get very interesting information from the photo analysis taken with the use of ThermaCam PM 590 thermovision camera(produced by American company FLIR) [5]. The process of the moulding cooling immediately after the injection was recorded. The figures 4a and 4b show that the temperature distribution is not symmetrical.

We can observe that thicker part of the moulding is giving up the heat longer while the remote parts and the less-thick parts are cooling faster. The analyzing program allows also drawing the temperature profile on the surface of moulding which is presented on fig. 3a, b.

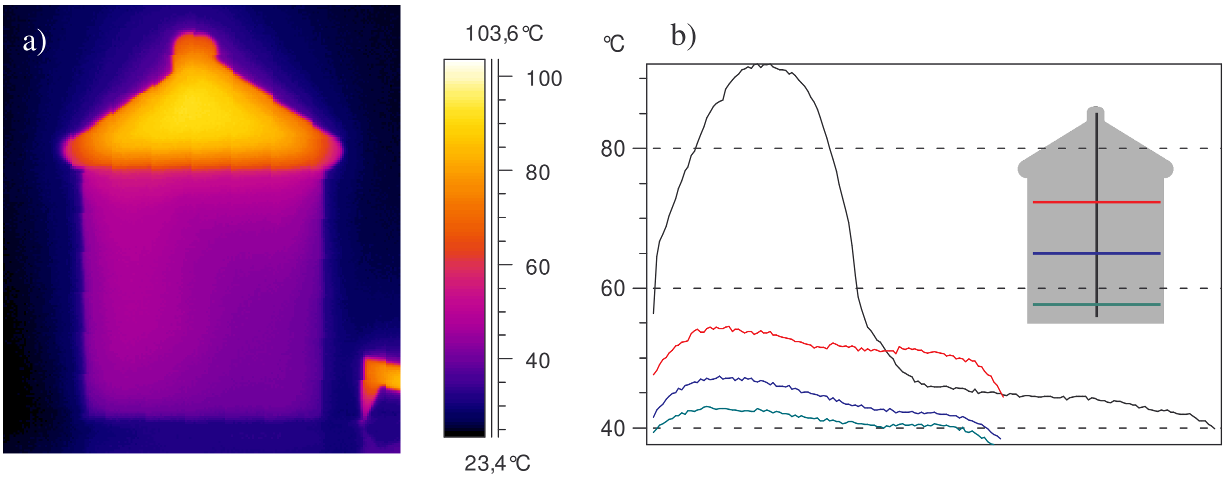

Figure 3. Results of investigations taken using thermovision camera: a) temperature distribution on the moulding surface, b) temperature profile in other parts of the moulding

4.3. The results of structure analyzing of polymer using the method DSC

The research of differential scanning calorymetry (DSC) method provides the significant information concerning the structure of polymer[6]. During the DSC research 9 samples form the surface of a moulding were taken according to the scheme shown on fig. 4b. The crystalinity degree, the enthalpy of phase transition and the melting temperature were estimated. The results of crystalinity distribution are shown in figure 4a.

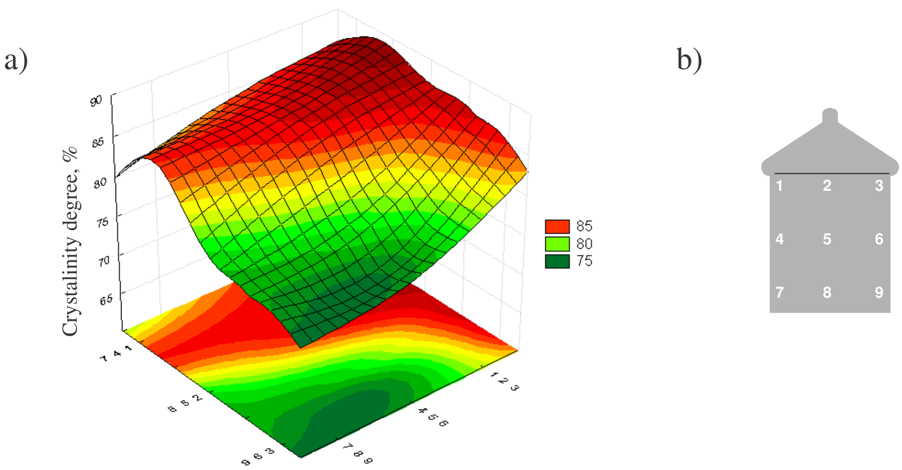

Figure 4. Results of DSC investigation: a) crystalinity distribution, b) points of DSC measurement

CONLUSIONS

The analyses of the effect prove that we should follow the conditions polymer processing and be concerned with stability of the process. It is very significant in the production of the dimensional accurate parts.

Recognition of all of the possible relationships describing influence of parameters on each other will enable exact and accurate injection process control and conscious decision-making (on manufactured parts quality improvement). It must be clear that such in-depth process recognition is necessary only when one wants to manufacture parts whose quality and repeatability requirements of all features (not only mechanical but also functional, quality) are imposed at the first place.

Wherever these properties matter, in-depth analysis of the whole process and all possible parameters is therefore necessary. Main recipient of such information are automotive, medical, precision and electronic industries.

REFERENCE

1. DuPont Polska, *Wymiary detali podczas formowania i po jego zakończeniu*, Vademecum Tworzyw Sztucznych i Gumy, nr 2, 2001 r.
2. Johannaber F., *Wtryskarki*, seria Przetwórstwo Tworzyw Sztucznych, Wydawnictwo Poradników i Książek Technicznych, Plastech, Warszawa 2000 r.
3. Kowalska B., Sikora R., *The influence of the cooling time of the injection moulded parts on pVT behaviour*, The Polymer Processing Society, PPS-17 Conference Proceedings, 21-24.06.2001, Montreal, Canada
4. Lackowski B., *Czynniki wpływające na dokładność wymiarową wyprasek wtryskowych*, Mechanik nr 8-9, 1992
5. Minkina W. A., Rutkowski P., Wild W. A., Podstawy *pomiarów termowizyjnych cz. I*, Pomiary Automatyka Kontrola, nr I/2000, str. 7-13
6. Möhler H., Knappe S., *Focus on thermal analysis for polymers*, NETZSCH-Gerätebau GmbH, Selb, 1998
7. Sikora R., *Podstawy przetwórstwa tworzyw wielkocząsteczkowych*, Wydawnictwo Uczelniane Politechniki Lubelskiej, Lublin 1992 r.