ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume VII (XVII), 2008

THE INNFLUENCE OF PACKING PRESSURE AND PACKING TIME OVER THE QUALITY OF INJECTION MOLDED PIECES

Dan Chira, Alexandru Rus

University of Oradea
E-mail: dan.chira@rdslink.ro, Web page: http://www.uoradea.ro

Key words: Injection molding, packing pressure, packing time, injection molded piece quality,

Abstract. Injection molding process have two important phases: 1st-the plastifying-dosing phase, which serves to prepare the optimal melting from the point of view of reological property, and 2-nd – the injection and compacting phase of the melted material. During the second phases over the melted materials is applied an injection pressure, and after this, the packing pressure. The packing pressure can be development up to various values by the hydraulic system, result different values of compaction of melted material, resulting different values for the injection molded piece mass.

1. THEORETICAL CONSIDERATIONS.

In case of injection molded process, the general equation of thermodynamic state should be particularized, since the injection process takes place within a constant volume, equal to the volume of matrix cavity to be filled. No matter the the value of injection pressure, the melted material will take up all the volume of the matrix cavity. Whence it results that the volume of the melted material from matrix cavity will equal the value of a specific volume equal to the general case, under a certain temperature and pressure, respectively; figure 1.The equivalent specific volume, according to the pressure of the applied injection, is given by the relation:

$$V_M = V_{spTPi} = V_P\,[\,1 + \alpha_V^{\,kpi}\,(\,Tm - To\,)] = ct. \qquad (1)$$

Where: -α_V - volume dilatation coefficient, indicate the effect that temperature has upon the melted material's volume; - k_{pi} – correction factor of the volume dilatation coefficient, minding the pressure that melted material undergoes ; T_m- temperature of the melted material carries during the injection process ; T_0- room temperature, 20ºC,

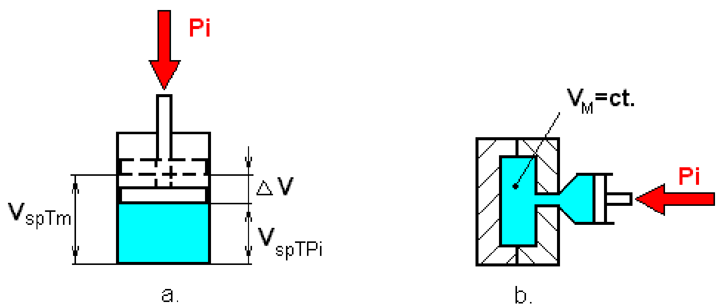

Fig.1. *Specific volume variation of the melted material with temperatureand pressure:*

a- general case, b- injection molding case

An extremely important theoretical issue to be debated here, with direct implication upon the practical aspects of the injection process, is the variation of relative density of the melted material with the injectin pressure. The variation of relative density of the melted material with the injection pressure is given by the relation:

$$\rho_{spTPi} = \frac{\rho_o}{1 + \alpha_v^{k_{pi}}(T_m - T_o)} \quad [\frac{kg}{m^3}] \qquad (2)$$

The variation grafic of the reletive density with the injection pressure is presented in figure 2.

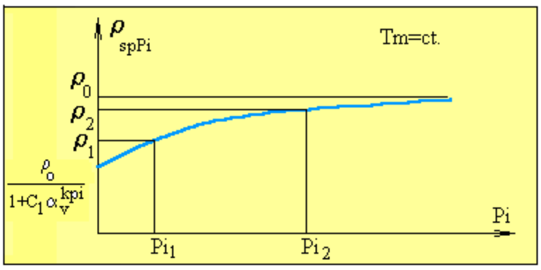

Fig.2. *The grafic of the relative density variation with the injection pressure.*

The quality of injection molded piece is given by the value of shrinkage and warpage. For little value for shrinkage and warpage we have a very good quality of injection molded piece.

The value of shrinkage is given by relation :

$$C_v = \frac{\alpha_v^{k_{pi}}(T_m - T_o)}{1 + \alpha_v^{k_{pi}}(T_m - T_o)} \qquad (3)$$

The variation grafic of the shrinkage with the injection pressure is presented in figure 3.

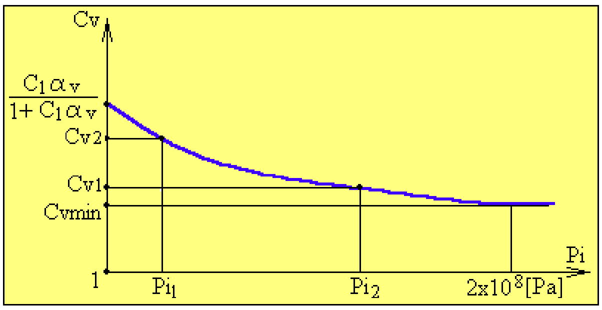

Fig.3. *The grafic of the shrinkage variation with the injection pressure.*

By comparing the variation grafic of the piece’s shrinkage with the variation grafic of the relative density, we notice that the two vary indirect proportionally.

This is a very important issue, because the mass of the injection molded piece becomes an indicative of the injection molded piece quality.

In injection molding process the packing time follow the fill time, figure 4. During the packing time is apply the packing pressure, with purpose to introduce an supplementary quantity of melt inside the mold, for compensation the diminution of volume due the cooling. Is necessary to keep the packing pressure until the gate freeze. To remove quickly the packing pressure, equivalent with an small packing time, without the gate freeze, allow to the melt to flow back from the mold. Result an diminution of injection molded piece mass, with negative influence over the shrinkage and warpage, existing an correlate between the mass and shrinkage and warpage. In the same time, a too long packing time lead to unjustified energetic consumption.

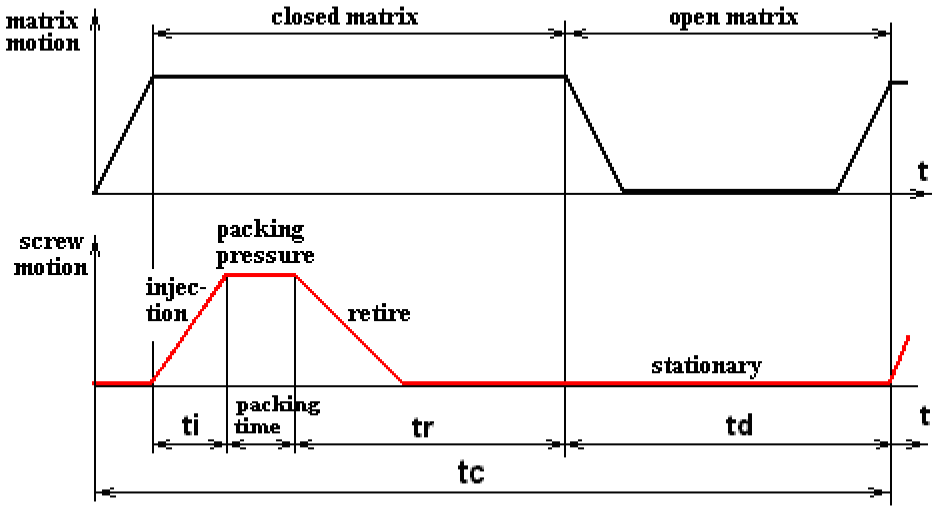

Fig. 4. *Grafic of matrix and screw motion In injection molding process:* t_i*- injection time,* t_{Pul}*- packing time,* t_r*– cooling time,* t_d*- demulation time,* t_c *–cicle time,*

2. EXPERIMENTAL RESEARCHES.

Our experimental researches were atergeted to confirming our theoretical suppositions referring to the mass of the injection molded piece, as they are featured in first part.

For experimental researches setting up on the injection molding machine the following condition: a continuous regulating of the injection pressure with the help of the proportional hydraulic elements featured; a regulation of the injection pressure so that, by the end of the injection process, it equals with the packing pressure; the injection of the melted material is to be carried out at a constant injection speed. We are setting on injection machine value for packing pressure from 600 to 1200x10^5 Pa, and for cooling time three series: 28 s., 38s. and 48 s.

In figure 5 is present the graphic of injection molded piece mass with injection pressure, equal with packing pressure, result after experimental injection. In figure 6 is present the graphic variation of shrinkage with packing pressure.

Experimental researches confirm the theoretical aspects, increase of injection molded piece mass with packing pressure and a diminuation of shrinkage with packing pressure.

The packing time have a very important influence over the injection molding piece mass, implicitly over the quality of injection molding piece due the variation of mass.

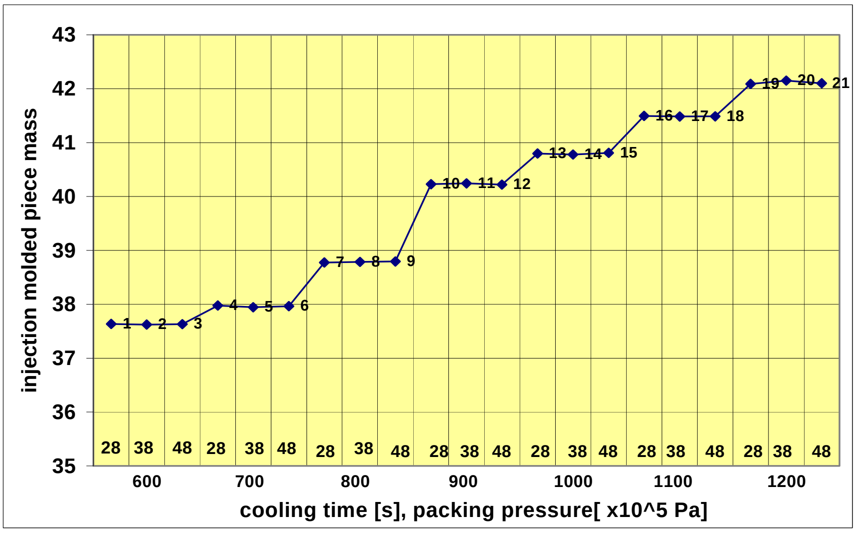

Fig.5. *The graphic of variation of injection molded piece mass with packing pressure and cooling time.*

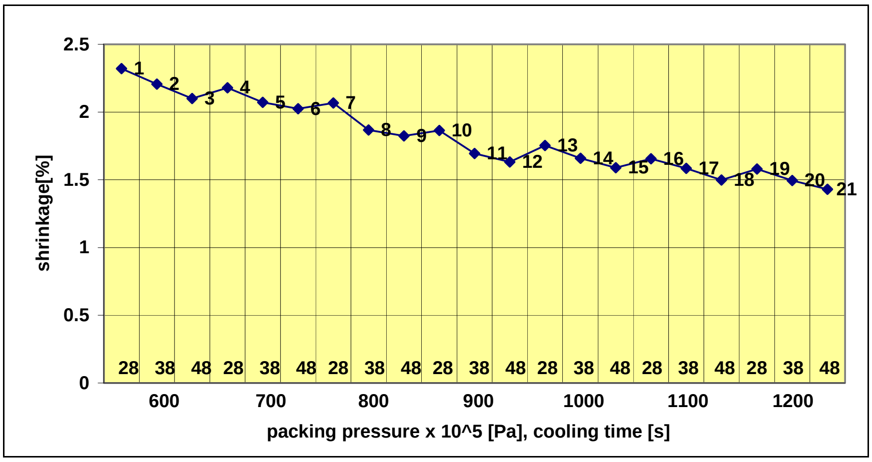

Fig.6. *The graphic of the shrinkage variation of injection molded piece with packing pressure and cooling time.*

Bibliography:

[1].Chira Dan., - Influența variației volumului topiturilor de materiale termoplastice cu temperature şi presiunea asupra fazei de dozare-plastifiere la maşinile de injectat. Sesiunea de comunicări ştiințifice, Universitatea Oradea , 2003,

[2]. Jinescu, V.V. – Proprietăți fizice şi termodinamice ale materialelor plastice. Bucureşti, Editura Tehnică, 1979.

[3]. Şereş, I.V. -Injectarea materialelor termoplastice. Oradea, Editura Imprime-riei de Vest, 1996.