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THEORETICAL CONSIDERATIONS AND EXPERIMENTAL RESEARCHES REGARDING THE VARIATION OF INJECTION MOLDED PIECE MASS WITH INJECTION PRESSURE AND COOLING TIME

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

1. Theoretical considerations

The injection molding process of macromolecular materials suppose to presurising the melted material encassed in a matrix whose form it takes after solidifying. The injection-molding process is a cyclical phenomenon. Broadly speaking, and without a clear-cut distinction, there are six main phases of an injection cycle, as follows:

- feeding with material,
- melting the material in the machine-cyllinder,
- closing the matrix,
- injection of melted material into the matrix ,
- solidification and cooling of the melt in the matrix,
- open the matrix and removing the injected piece.

There are two aspects of the injection process to be defined here. The first has to do with the injection machine and it deals with preparing the material for injection, the fuelling and dosing the cyllinder with the material, melting the material and injection it into the matrix. The second has to do with the injected matrix and it deals with the actual processing of the injected piece, that is to say, with filling up the matrix with the melted material, compacting the matrix, cooling the material and removing the peice from the matrix.

The main factors that help with optimising the results of the injection process are the reological properties of the macromolecular material, temperature control and pressure control. To these, we can add the duration of the injection cycle - complete with the injection timing, the time-span of ulterior pressurizing, the duration of the cooling process, and the demulation process - that can influence the quality of the injected piece as well as the productivity of the entire injection process.

The parameters of the injection process are analysed as enter-exit sizes, during two important phases of the injection process:

- the plastifying - dosing phase, which serves to prepare the optimal melting from the point of view of reological property, of structural homogeneity, of termic homogeneity, with optimal viscozity, in order to create the best conditions for flowing and pressure transfer. During this phase, the enter sizes are: the temperature to be set on the length of the cyllinder of the injection machine, the screw turation, the plastification counter-pressure and the screw timing of rotation. The exit sizes are: the temperature of the melted material, the reological properties of the material and the melted quantity prepared for injection.

- the injection and compacting phase of the melted material. This phase takes the exist sizes from the plastifying - dosing phase, to which it adds: the injection pressure, the injection speed, packing time and the cooling time of the melted material in the matrix.

In the case of injection 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 the matrix cavity to be filled. No matter the value of the 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 the matrix cavity will equal the value of a specific volume equal to the general case under a certain temperature and pressure, respectively; figure 1.

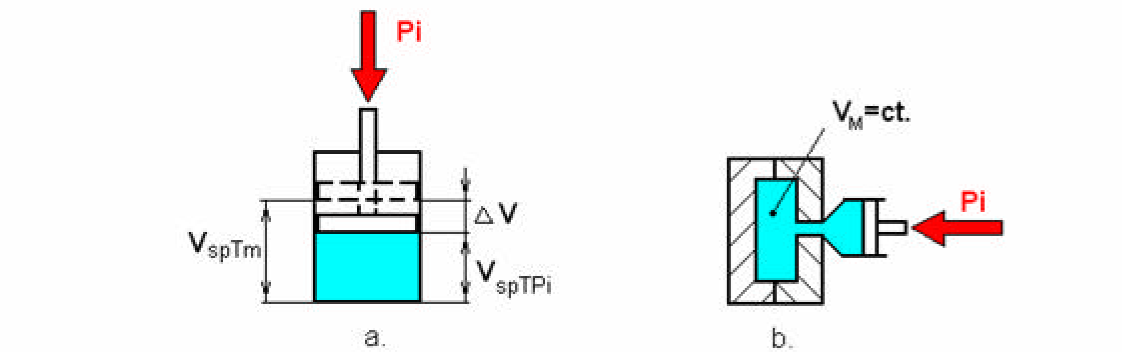

Fig. 1. Specific volume variation of the melted material with temperature and pressure: a-general case, b-injection molding case,

The equivalent specific volume, according to the pressure of the applied injection, is given by the relation:

$$Vm = VspE = Vp\,[\,1 + a_v^{\,kpi}\,(\,Tm - To\,)] = ct \tag{1}$$

where: - a_v - volume dilatation coefficient, indicating the effect the temperature has upon the melted material's volume;- kpi- correction factor of the volume dilatation coefficient, minding the pressure that the melted material undergoes; - Tm -temperature the melted material carries during the injection process; - To-room temperature,

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

$$?_{sp\ TPi} = \frac{?o}{1 + C_1 a_v^{\,kpi}} \tag{2}$$

The variation graphic of the relative density with the injection pressure is presented in figure 2.

One important application of this variation of he relative density is the possibility to obtain pieces with differing mass according to the injection pressure; we must bear in mind that the injection takes place in a constant volume of the matrix hole to be filled.

$$mp = ?_{spTPi}\ Vm \tag{3}$$

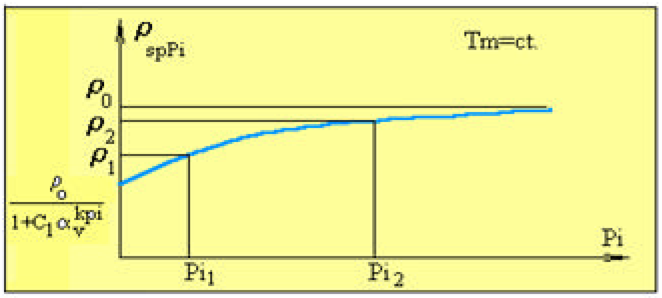

Fig. 2. The graphic of the relative density variation with the injection pressure.

This is a very important issue, because the mass of the injection molded piece becomes an indicative of the injection molded piece quality. By comparing the variation graphic of the piece's shrinkage with the variation graphic of the density, we notice that the two vary indirect proportionately. What we get as a result of that is a very feasible practical aspect of the matter: using only a high-precision scales to weight the injection molded pieces, we get the first data concerning the quality of the piece, and we can also regulate the injection pressure.

2. Experimental researches.

For experimental researches we setting up of the injecting machine will be done with 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 the ulterior pressure; the injection of the melted material is to be carried out at a constant speed.

Our experimental researches were atergeted at confirming our theoretical suppotitions referring to the mass of the injected piece, as they are featured in subchapter 1. As already stated, the mass of the injected piece is determined by the injection pressure. For experimental researches we have take

Also cooling time is one of the most important parameter of injection molding process, who have influence over the quality of injected molded piece. For this reason we have studied the influence of cooling time over the injection molded piece mass. During the experimental researches we have take three time series of cooling time in the matrix, 28s, 38s and 48s.

In figure 3 we have featured the graphic of the variation of the injection molded piece with the injection pressure and the matrix cooling time.

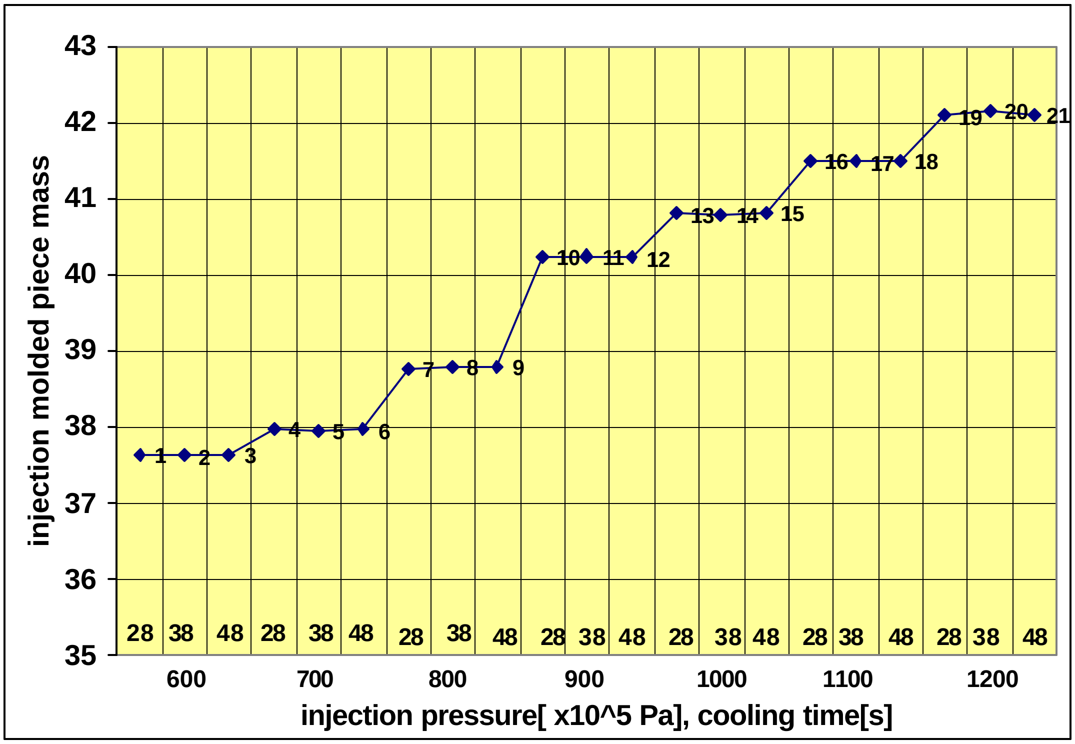

Fig. 3. The graphic of the weight variation of injection molded piece with the injection pressure and the matrix cooling time.

Conclusion: - the injection molded piece mass increase with injection pressure,
- the injection molded piece mass is not depend by cooling time,
- experimental researches confirm the theoretical aspects,

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