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DIMENSIONAL AND TOLERANCE CHANGES IN INJECTION MOLDING PROCESS

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Key words: shrinkage, mould dimensions, process condition, materials,

Abstract: In injection moulding process appears a diference between mould dimensions and injection moulded piece dimensions. This diference appears due the shrinkage of thermoplastic materials. The shrinkage is influenced by mould, injection moulding process conditions and properties of thermoplastic materials. Dimensional and tolerace changes an injection moulded piece is a sum of this.

1. Dimensional and tolerance changes an injection moulded piece in course of time.

The cooling an injection moulded pieces begin from melt temperature and stop to room temperature, in a solid state. Before the piece is ejected, the shrinkage and the warpage has been development inside the mould, and after ejection at room temperature.

Resultant dimensions and tolerance of injection moulded piece is present in figure 1.

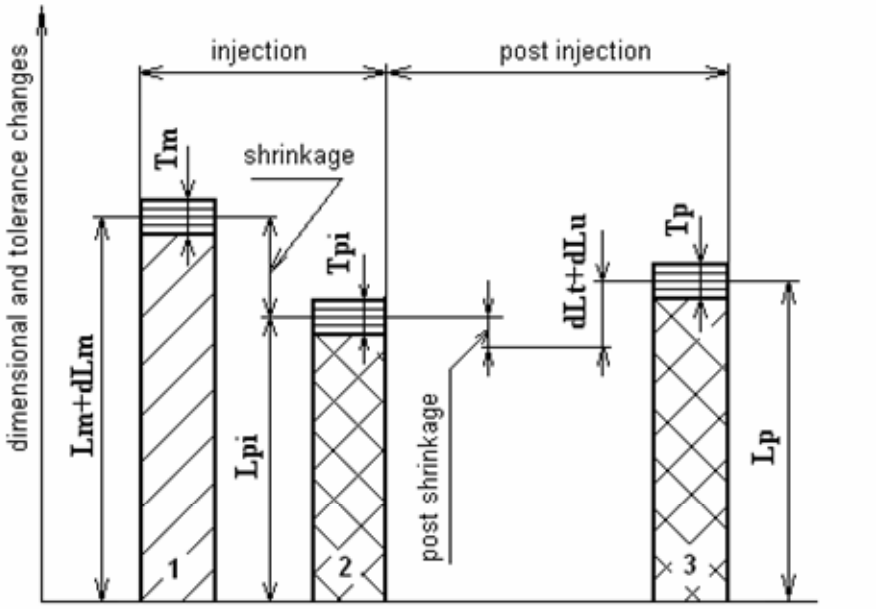


Fig.1. Resultant dimensions and tolerance of injection moulded piece.
1- L_m- dimensions of cold mould at 20°C ; dL_m –thermal and elastic expansion of mould ;
2- L_{pi}- dimensions of moulded piece after ejection from mould ; dL_t+dL_u- dimension increase with exploitation temperature and absorption of water; 3- L_p- exploitation dimension, T_m- mould tolerance, T_{pi}- injection moulded piece tolerance after 24 h, T_p- injection moulded piece tolerance in exploatation,

The measurement of manufacture tolerance,T_{pi}, is making after 24 hours, in normal conditions, at 20°C temperature and 50% relative humidity. For a normal injection the quota dispersion must to be ±s inside of tolerance, in according with Gauss curve.

Injection moulded piece can be used at different temperature(<60°C), static or dynamic stress, and for this reason appears variation from nominal quota. Nominal dimension is

determinate after 168 hours, in according with exploitation temperature, coefficient of volumic expansion and post-shrinkage coefficient.

$$L_p = L_{pi}[1-a+\alpha_v(\theta_s-\theta_i)] \quad (1)$$

Where: - a – post-shrinkage coefficient, specific feature of material,
- α_v - coefficient of volumic expansion, specific feature of material,
- θ_s - exploitation temperature,
- θ_i – room temperature, 20°C,

Dimensional and tolerance changes an injection moulded piece in course of time is present in figure 2.

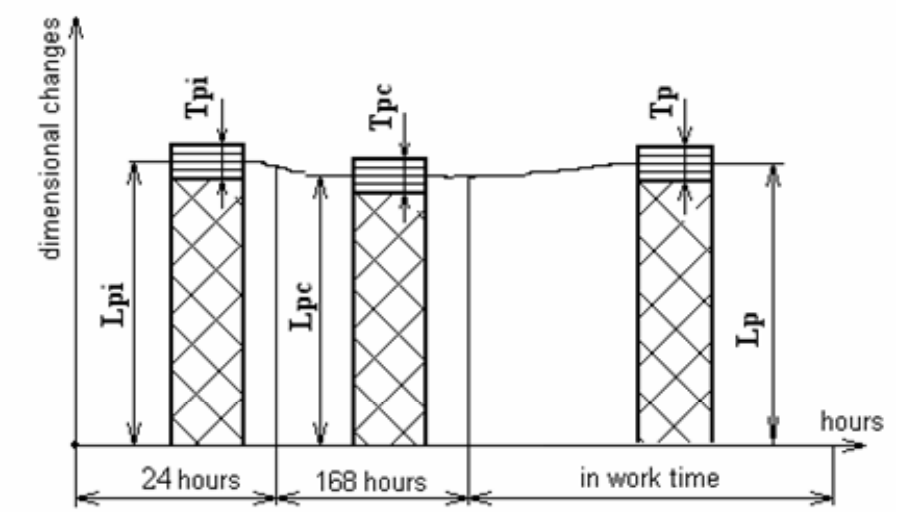


Fig.2. Dimensional and tolerance changes an injection moulded piece in course of time.
L_{pi}- dimensions of moulded piece after ejection from mould, - L_{pi}- dimensions of moulded piece after post-shrinkage, - L_p- exploitation dimension,

Injection parameters have an important influence over shrinkage, dimension and tolerance of injection moulded piece. In formula (2) is present the general equation of volumetric shrinkage coefficient with injection pressure, melt temperature, mould temperature and cooling time. [1].

$$C_V = \frac{\alpha_v^{k_{pi}}(T_m - T_M)(1+\frac{4}{\pi}\bullet\frac{1}{e^{C_2 t_r}})}{1+\alpha_v^{k_{pi}}(T_m - T_M)(1+\frac{4}{\pi}\bullet\frac{1}{e^{C_2 t_r}})} \quad (2)$$

Where: - k_{pi} – correction coefficient, indicate the influence of injection pressure over coefficient of volumic expansion, specific feature of material,
- T_m – melt temperature,
- T_M – mould temperature,
- t_r – cooling time,

In table 1 is present the influence of process conditions, material properties and mould construction over shrinkage

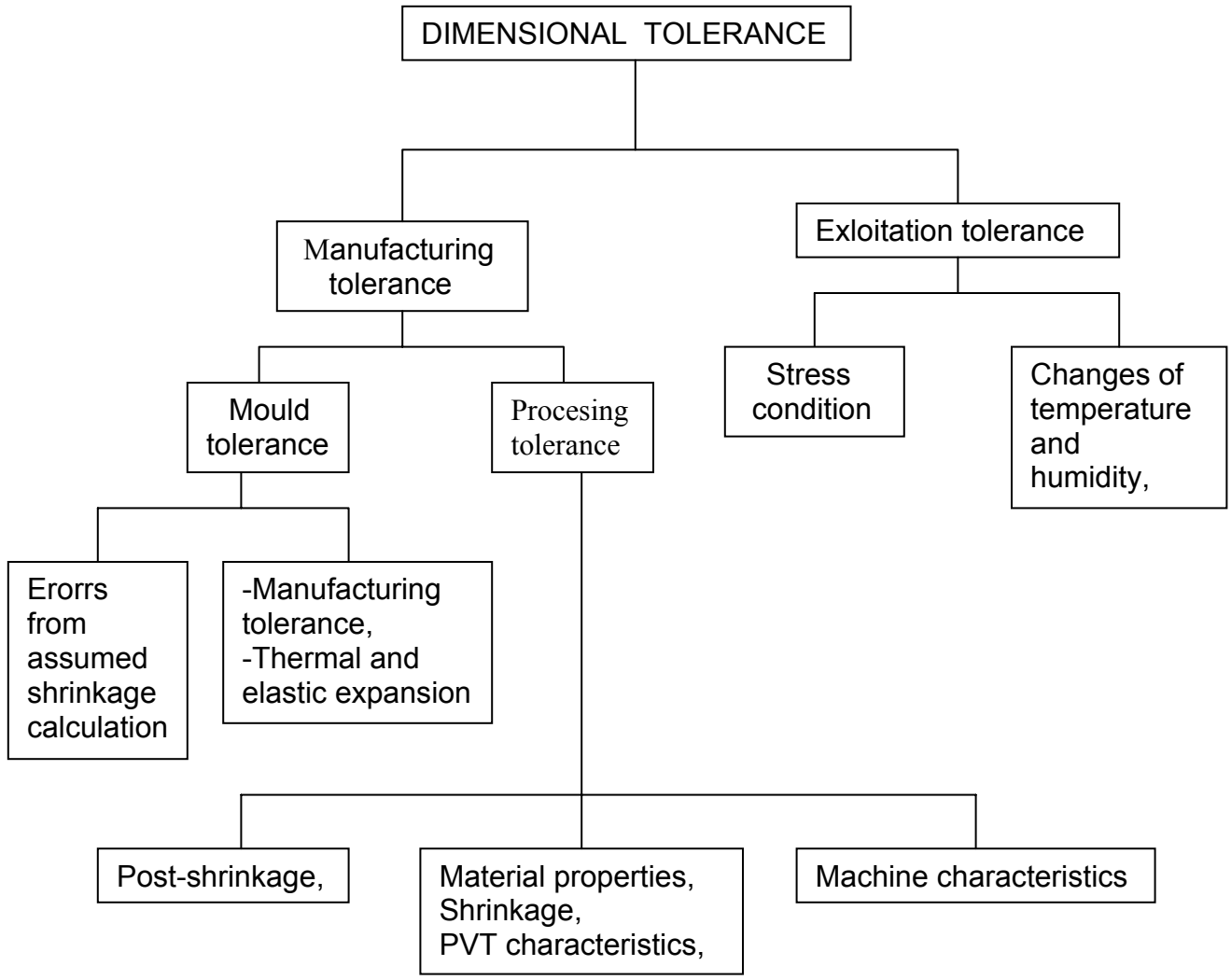
Table 1.

Parametru	**Shrinkage**	
	decrease	**increase**
Process condition	- high injection pressure	
	- high holding pressure	
	- high injection rate	
	- high cooling time	
		- high melt temperature
		- high mould temperature
Materials properties	- amorphous	
	- reinforced	
		- crystalline
		- higher wall thicness
Mould construction	- high conductivity steel	
		- high mould temperature
		- small gate area
		- small clamp force

Injection moulding quality process is a sum of factors, which must to be treated as a unit of this. In table 2 are present the factors influencing injection moulding quality.

Table 2.

Factors influencing injection moulding quality		
Mould	**Machine**	**Material**
- wall thicness, - gate location, type,size, - runner size, - air ventilation, - uniform melt flow, - ejection mode,	- plasticating rate, - maximum injection capacity, - maximum injection pressure - number of pressure phase, - clamp force, - injection rate, - cicle time,	- PVT characteristics, - melt index flow, - shrinkage coefficient, - shear rate, - heat and thermal stability, - molecular weight, - hygroscopic or not,



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