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DETERMINATION OF THE INFLUENCE OF PARAMETERS OF INJECTION MOLDING USING THE TAGUCHI METHODS

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ABSTRACT
Injection molding is one of the most popular polymer processing methods due to its high production rate as well as its ability to produce very complex geometries at very low cost and within few seconds. In this the paper, optimal injection moulding conditions for minimum shrinkage during moulding are found by technique (Taguchi method). Taguchi method has two main instruments, which are signal-to-noise (S/N) ratio and orthogonal arrays. S/N ratios were used for determining the optimum combinations of the process conditions for shrinkage. Finals, optimum levels of the input parameters that minimize shrinkage, for both materials are determined
Keywords: Injection pressure, parameters of injection moulding, shrinkage, Taguchi method.

1. INTRODUCTION
Optimizing process parameter problems is routinely performed in the manufacturing industry, particularly in setting final optimal process parameters. Final optimal process parameter setting is recognized as one of the most important steps in injection molding for improving the quality of molded products (Mok and Kwong, 2002) [1]. Previously, engineers used trial-and-error processes which depend on the engineers’ experience and intuition to determine initial process parameter settings. Subsequently, numerous engineers applied Taguchi’s parameter design method to determine the optimal process parameter settings. However, the trial-and-error process is costly and time consuming, thus it is not suitable for complex manufacturing processes (Lam et al., 2004). Hsu (2004b) argued that when using a trial-and-error process, it is impossible to verify the actual optimal process parameter settings. Moreover, Taguchi’s parameter design method can only find the best specified process parameter level combination which includes the discrete setting values of process parameters. Application of the conventional Taguchi parameter design method is unsuitable when one of the process parameter variables is continuous, and it cannot help engineers obtain optimal process parameter setting results (Su and Chang, 2000). Furthermore, when engineers deal with a multi-response process parameter design problem, the conventional Taguchi parameter design method runs into difficulties (Hsu, 2004a). Nowadays, for coping with the diversifying demands of present markets, developed countries in industry have been introducing the technologies of computer-integrated manufacture (CIM) as CAE/CAD/CAM to get competitive advantages [2–3]. That is, for the manufacturing process of an industrial product with completed design, first, its prototype is designed by the original concept. Next, through computer-aided design (CAD) tool complete the initial design. Third, by the analysis technology of computer-aided engineering (CAE) to test and modify the design. Finally, depending on the better design, automotive production can be done by

computer-aided manufacture (CAM). Before concurrent engineering attracting much attention, the technologies of computer-aided engineering analysis were seldom used to estimate designing faults by manufacturers in advance. Where, mold design and manufacturing process should be modified through many times of trial-and-error tests [4]. It not only wastes time and cost but also makes such experiences became more difficult in teaching or accumulating. Besides, under the situation of different product required or new materials, the awkward problems as one more times of teaching experience and molding cannot be avoided. Sometimes part of business chances may be losing for it. The most helpful function of CAE is to carry out simulation analysis of prototype design by computers.

2. EXPERIMENTAL METHOD

The data is based on a modified orthogonal array in Taguchi methode. The selected input parameters include, melting temperature, packing pressure, packing time and injection pressure. Shrinkage, which is one of the most important criteria, is selected as output. Level of input parameters in each experiment and the measured results are shown in Table 1.

Tabela 1. *Taguchi L27 Orthogonal Array*

The simulation experiment					
Expet. No	factor variations			result analysis	
	T_a	V_i	P_n	Mass feedstock (g)	S/N ratio
1	40	5	110	75,7586	37,5886
2	40	5	120	75,7656	37,5894
3	40	5	130	75,7668	37,5896
4	40	10	110	75,7822	37,5913
5	40	10	120	75,7833	37,5915
6	40	10	130	75,7866	37,5918
7	40	15	110	75,8016	37,5936
8	40	15	120	75,8011	37,5935
9	40	15	130	75,8124	37,5948
10	50	5	110	75,7921	37,5925
11	50	5	120	75,7913	37,5924
12	50	5	130	75,7970	37,5930
13	50	10	110	75,8028	37,5937
14	50	10	120	76,7112	37,6972
15	50	10	130	76,7114	37,6972
16	50	15	110	76,7175	37,6979
17	50	15	120	76,7235	37,6986
18	50	15	130	76,7172	37,6979
19	60	5	110	76,7368	37,7001
20	60	5	120	76,7365	37,7000
21	60	5	130	76,7387	37,7003
20	60	10	110	76,7367	37,7001
23	60	10	120	76,7455	37,7011
24	60	10	130	76,7419	37,0007
25	60	15	110	76,7477	37,7013
26	60	15	120	76,7582	37,7025
27	60	15	130	76,7368	37,7001

The result shows the time of filling the position of the flow in a given time interval, as the tool cavity to be filled. Each colour represents the part of the contour in the tool cavity, which is filled at the same time. At the beginning of the injection result is blue, and the place that the last replenishment are red. Places of components which have not been fulfilled without a fight. If the component is well filled in a given time flow or flow is balanced. Under the concept of a balanced flow is considered that all the components in a particular place at the same time filled.

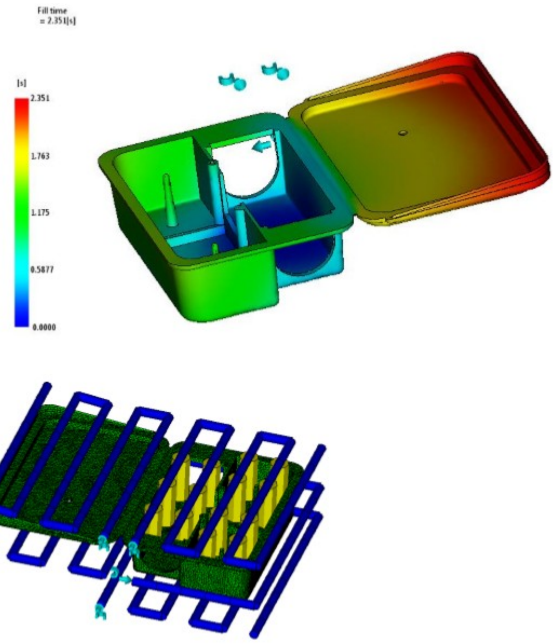

Figure 1. FEM module with cooling channels

The figure clearly shows that the first body filled boxes and then the cover. Critical area filling can be determined by analysing the results of time filling in certain time intervals. The picture shows that at the time 1 [s] a noticeable difficulty filling the right side of the model, is the cover. The reason for a longer time required for filling the cover is difficult to flow feedstocks because of the geometric shape of the small portion that folds to cover could close. In addition to filling can affect the position of the selected estuary, and only cooling molten feedstock and in areas closer to the walls of the tool cavity. With increasing temperature of the die reduces the temperature difference feedstock and the tool cavity wall resulting in a slower cooling, subsequent solidification, and thus sealing the mouth of the later. A direct consequence of later sealing the mouth of the greater weight of the part.

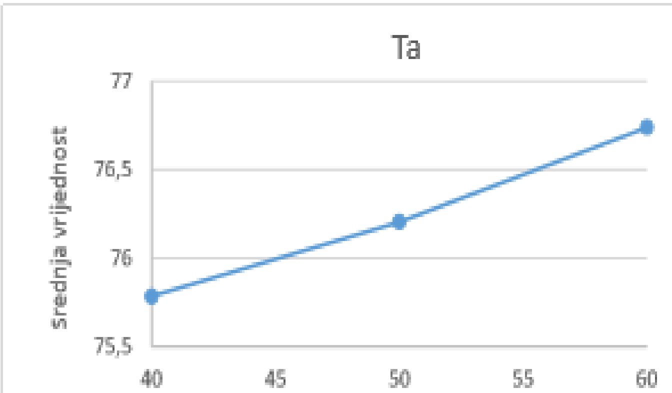

Figure 2.S/N ratio curve for temperature

The experiment results indicate that the increase of the injection rate increases and the weight. This can be explained by the fact that higher speed injection means higher shear rate and more heat generated by the effect of viscous heating. This results in an increase in the temperature of the molten feedstock for a given temperature tools, holding press estuary and thus greater weight. Also increase in speed increases the pressure in the phase of operation subsequent pressure, which again leads to an increase in weight.

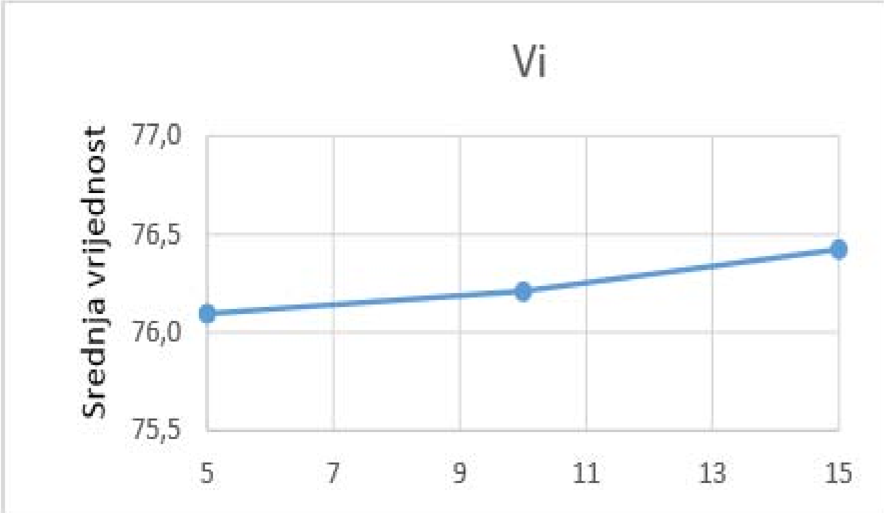

Figure 3. S/N Ratio Curve for Coolant Flow Rate

3. CONSLUTION

In this paper, I designed a tool for injection moulding of plastic products using the software SOLIDWORKS and MOLDFLOW. Positioning and mounting parts within, gets a virtual prototype of the product tools. By changing the design of the model, at any time, change and are connected to other parts, and technical documentation itself. Based on the results of the FEA simulation, if the material properties, initial and boundary conditions properly given, it is in the process of filling predict: the dynamics filling tool cavity, the occurrence of nozzle effect, places the line of connection, of excessive heat melted feedstock, a place of installation channel vent of temperatures, pressures, shear rate, viscosity in time, the dynamics of the molten feedstock curing times. Changing parameters and using Taguchi method was obtained optimum variance in operation smallest shrinkage of the workpiece.

4. REFERENCES

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