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OPTIMIZATION OF INJECTION MOLDING PROCESS

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ABSTRACT
The process conditions in injection moulding have critical influence on the part quality; so finding the optimum process parameters is the key to optimizing part quality. This article describes using of Moldflow Plastic Expert (MPX) for optimization of injection moulding process. This article deals with the description of Moldflow Plastic Expert (MPX) principle and its usability in optimization of injecting conditions for the given part.
Keywords*: injection molding process, injection mold, polymer, optimization*

1. INTRODUCTION
Optimization of the injecting process is used for finding the "ideal" conditions for injecting products of given dimensions, shape and characteristics. With the help of optimization, it is possible to set the required injecting pressure, injecting speed, size and duration of holding pressure etc. The result of optimization leads to products of required quality and acceleration of the process of implementation of the new product into production.

2. MOLD FLOW PLASTIC EXPERT (MPX)
MPX is the control solution for automating setting, optimization and monitoring of the process conditions of the injecting machine. Contrary to other control settings, MPX may utilize the simulation capacity Moldflow Plastic Adviser and Moldflow Plastic Insight, software securing the default configuration process. Using the MPX, the operators may equally and systematically set the injection molding process, carry out the automatic DOE (Design of Experiment) and therefore evaluate whole injection molding process and especially the injected part. The MPX working station is connected to the injection molding machine Arburg 420C Allrounder and enables reciprocal resetting of the injecting parameters between the injection molding machine and MPX (Fig. 1).

Figure 1. Injection molding machine Arburg 420C Allrounder with Workstation MPX

3. INJECTION MOLDING PROCESS OPTIMIZATION

The other parts of this article suggest the procedure of optimization of the injection molding process of a selected part using MPX and display the results obtained by this optimization.

3.1. Injected part

A part was chosen for measuring purposes, which is used for preparing testing elements. Specifically, they are testing elements for tensile and flexural test, as seen on Fig. 2.

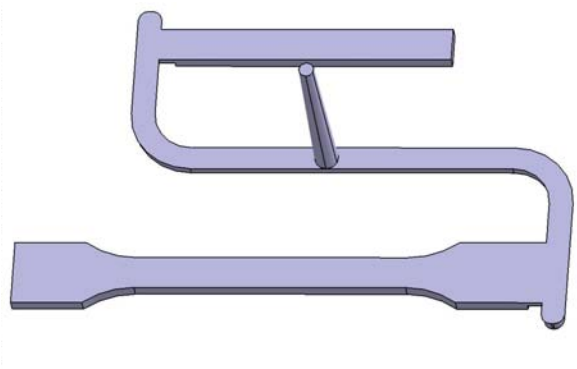

Figure 2. Injected part

3.2. Optimization

The optimization of the injecting process using MPX begins by the process setting, which deals with the optimization concerning changes in the speed profile, changes in holding pressure and cooling period. At the beginning of the process setting, it was possible to choose one of the four possibilities at the beginning of optimization using:

- settings guide,
- uploading the initial profile from the injecting machine,
- uploading the initial profile from the Moldflow Plastic Insight program,
- copying the profile of existing optimization .

It is possible to select from the automatic, assisted or manual settings when choosing the settings guide. It was necessary to set the temperatures of the heating zone for the given material manually before running the program. Setting the initial parameters for injecting as: the speed of stroke, injection rate, pressure in the hydraulic circuit and cooling time. Optimization was the subsequent step, which is made of two main parts.

Speed profile change optimization

• protection against mold overfilling
• filling optimization
• speed profile optimization
• setting the critical speed stroke
• measuring the flow characteristics of the material
• suggestion of the phase speed profile
• elimination of defects using the speed profile

Speed profile change optimization

• holding pressure optimization
• holding pressure time optimization
• defect elimination by the holding pressure
• cooling time optimization

4. OPTIMISATION RESULTS

Optimisation of injection molding process was first carried out by automatic settings and after by assisted settings. The initial parameters for injection molding by the assisted procedure were chosen and set manually. MPX program set these values for the given material by the automatic settings. The obtained values are represented in graphs of speed profiles (fig. 3) and graphs of pressure profiles (fig. 4).These initial and optimized (final) values are shown in Table 1.

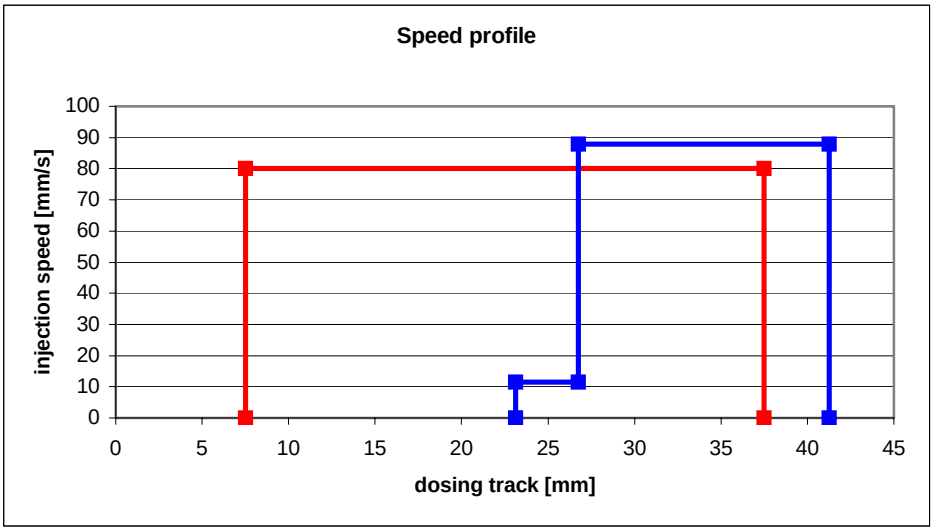

Figure 3. Speed profiles for automatic procedure of PP settings

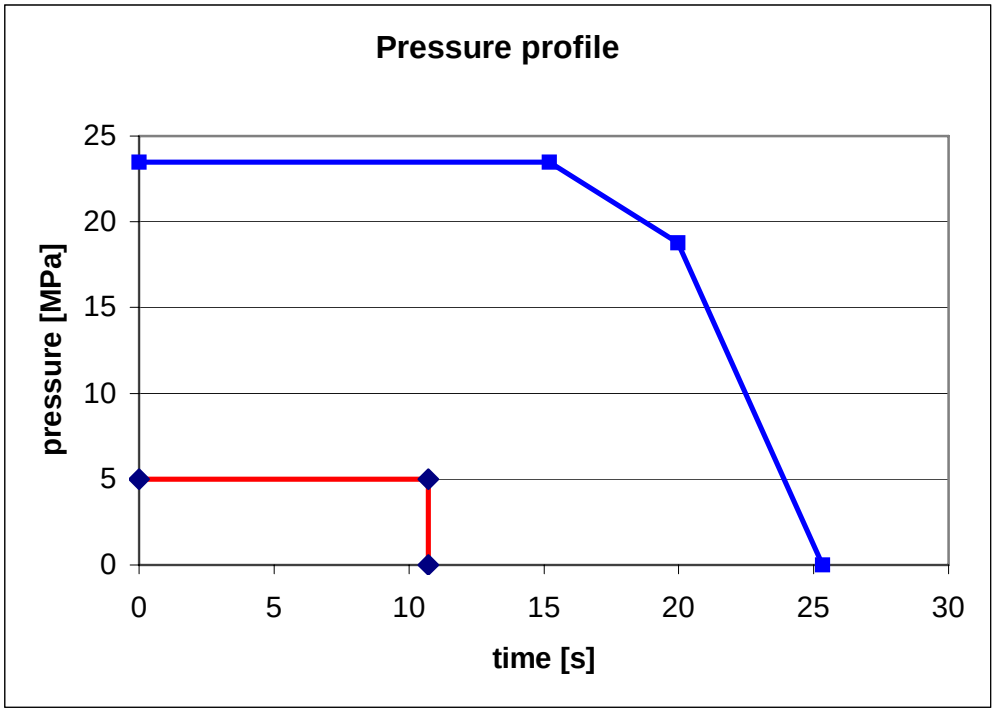

Figure 4. Pressure profiles for automatic procedure of PP settings

The following graph shows the dependence of holding pressure time on the mass of the spout. This graph is the result of holding pressure time optimization. The holding pressure time during optimization started at 6 seconds and was prolonged after every spout until the spout showed overfilling or there were problems with ejecting the spouts. Every piece was weighed, the results were made into a graph of the dependence of holding pressure on the spout mass.

Table 1. Initial and final parameters for injecting PP

	assisted procedure		automatic procedure	
	initial profile	final profile	initial profile	final profile
injecting speed [mm/s]	40	51,2	80	87,9
stroke speed [mm]	30	18,2	30	18,3
pressure in the hydraulic circuit [MPa]	9	9	9	9
cooling time [s]	17,5	2,43	25	4,69
filling time [s]	0,75	0,35	0,38	0,25
holding pressure time [s]	7,50	23,18	10,71	25,32
total time [s]	25,75	25,97	36,09	30,25

Table 2 shows individual optimization steps, time and number of pieces used for optimisation.

Table 2. PP optimisation progress

optimization	assisted procedure		automatic procedure	
	amount [pcs]	time [min]	amount [pcs]	time [min]
Protection against mold overfilling	0	0,00	0	0,00
Filling optimization	6	5,67	8	8,67
Speed profile optimization	10	8,32	18	53,37
Measuring the speed profile characteristics	3	1,97	3	1,91
Suggestion of phase speed profile	3	2,77	3	2,02
Defect elimination by speed profile	3	4,00	2	2,72
Holding pressure optimization	6	5,00	7	6,85
Holding pressure time optimization	9	13,67	10	10,95
Defect elimination by holding pressure	18	14,58	23	25,17
Cooling time optimization	3	1,40	4	4,18
Total	62	57,37	78	115,83

5. CONCLUSION

When comparing the results of the optimization of PP using the automatic setting procedure and assisted setting procedure, the assisted setting procedure proves to be better. The optimization during the assisted procedure was carried out in a shorter time at fewer cycles. It has better final parameters for injecting such as: lower injecting speed, lower stroke speed and shorter cycle time. These differences are the result of interfering into the optimization during the assisted setting procedure than during the automatic setting procedure.

6. ACKNOWLEDGEMENT

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7. REFERENCES

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