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UTILIZATION OF DMLS IN INJECTION MOLD DESIGN

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Abstract: *DMLS is a revolutionary technology that produces metal components, this process is not restrictive in its application and the components produced can be used on any place of almost any part. The main goal of this paper is to compare two cooling systems of the same part. One of them has been created by conventional methods of machining and the other one has been created by using DMLS.*
Key words: *injection molding, injection mold, DMLS, simulation*

1. INTRODUCTION

Direct metal laser sintering (DMLS) allows creating fully functional metal part directly from 3D data, without using any tools and without any shape restrictions. The parts produced by this technology have mechanical properties fully comparable with cast or machined parts. Benefits of this technology icreases with shape complexity that means the more complex part, the more economical the process becomes.

This technology belongs between so called additive technologies that mean that unlike milling or drilling where final part is shaped by removing material, in this technology is shaped by adding material (Stanek et al., 2009).

Principle of this technology is based on melting very thin layers of metal powder. The process begins by applying first layer onto a steel platform and melting required countour. Then is another layer applied and process continuous until the whole part is made. Minimal thickness of each layer is 20 μm.

It is also necessary to use supporting structure, which is applied simultaneously with base material. The supports are necessary because the powder itself is not sufficient enough to hold in place the liquid phase created by melting required contour (Rees, 2002).

Once the part is created then it goes through some finishing operations including support removal, shot peening and polishing. Between advantages belong besides shape complexity and cost and time savings, also possibility of recyclication of about 98% of not used powder.

It also has some disadvantages such as limited working space, higher acquisition cost and possibility of distortion due to residual stress (Kazmer, 2007).

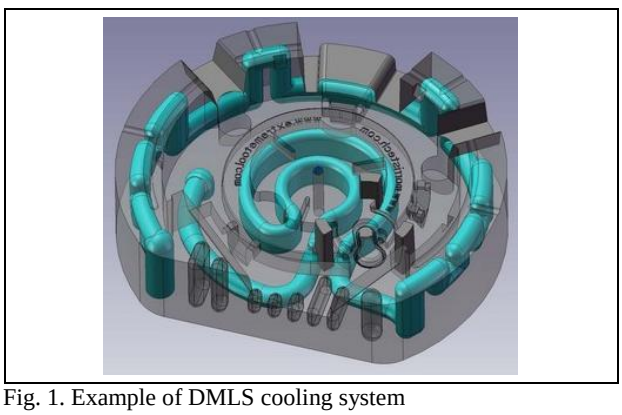


Fig. 1. Example of DMLS cooling system

2. EXPERIMENT

The main goal has been to design two cooling systems, compare them by using suitable software and at the end create economical evalutation. Each of the cooling system has been created by different technology. For creation has been used CAD software Catia V5, comparison has been done in CAE software Autodesk Moldflow Insight 2011 and for economical evaluation has been used Microsoft Excel 2007.

2.1 Injected part

As a sample of an injected product has been selected plastic seat for children, which is complicated enough to use DMLS technology. Its main basic dimensions are 359.1 x 398.8 x 373.8 mm (h x w x d).

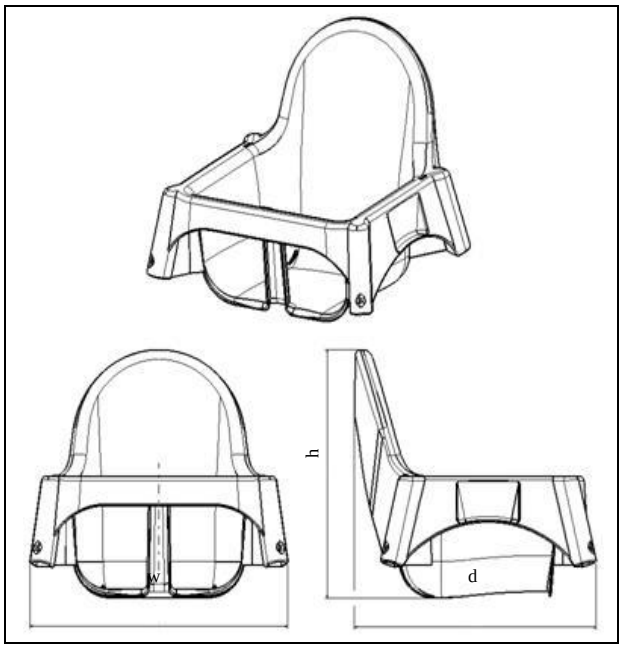


Fig. 2. Injected part

Polypropylen has been chosen as a material, due to its advantageous combination of processing properties, high stiffness, low prize and availability.

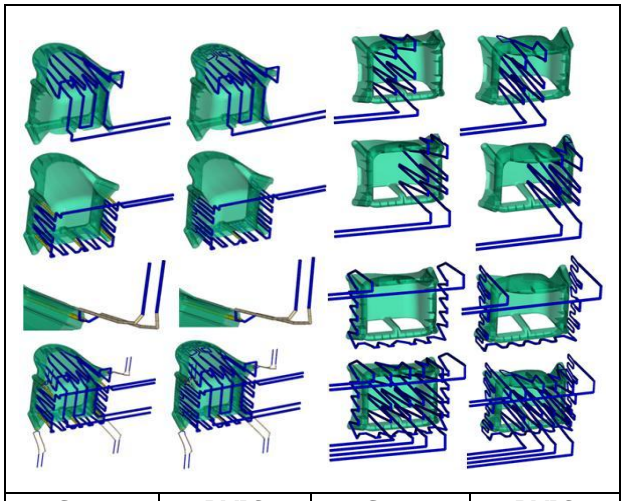
For comparison purposes has been used an existing material. As a supplier of this material has been chosen Borealis AG and its designation is Daplen BH 345 MO. Its basic properties can be seen in Tab. 1.

	Properties
Elastic modulus E [MPa]	1340
Shear modulus G [MPa]	481.3
Melt flow index MFI [g/10min]	45
Shrinkage [%]	1.34
Hardness [HRC]	89

Tab. 1. Material properties

2.2 Cooling systems

In both cases it has been effort to design as good cooling systems as possible, to determine whether DMLS will even pay off in creation of this particular cooling system.



Conv.	DMLS	Conv.	DMLS

Fig. 3. Core (left) and cavity cooling systems

Differences in both cooling systems can be seen in Fig. 3. it can also been that has been used same input and output cooling channels in both cases. Diameter of cooling channels has been from 6 to 12 mm.

For the injection molding process simulation purposes has been used same cooling liquid, which has been pure water. The temperature of this cooling medium has been set to 30 °C and pressure to 3.5 bar.

2.3 Comparison

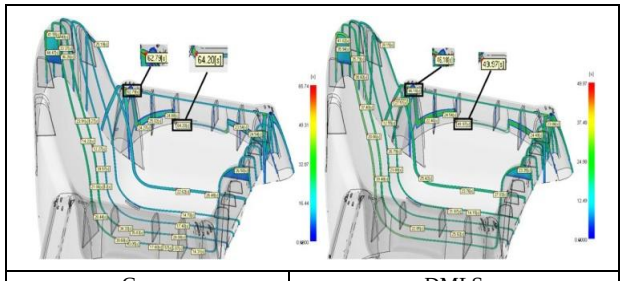
Comparison has been done under the same process parameters. Those can be seen in Tab. 2.

	Process parameters
Mold surface temperature [°C]	35
Melt temperature [°C]	200
Mold-open time [s]	5
Injection + packing + cooling time [s]	automatic
Filling control	automatic
Velocity/pressure switch-over	automatic
Pack/holding control	Filling pressure vs. time: 0s – 85%, 5s – 85%, 0s – 80%, 4s – 80%, 10s – 50%

Tab. 2. Process parameters

Among many different kinds of obtained results has been chosen as the most important time to reach ejection temperature result.

Time to reach ejection temperature has been about 66 s in conventional cooling system and about 50 s in DMLS cooling system as can be seen from Fig. 4.



Conv.	DMLS

Fig. 4. Time to reach ejection temperature

This result has shown that DMLS cooling system can in this case cool down the part in about 15 s faster than conventional cooling system. This leads to a shorter injection molding cycle and of course higher cost savings.

Despite higher investment costs of the DMLS cooling system it will pay off after 73512 cycles due to shorter injection molding cycle as can be seen in Fig. 5. That means that if the planned production is higher than 73512 cycles then DMLS cooling system is a better option.

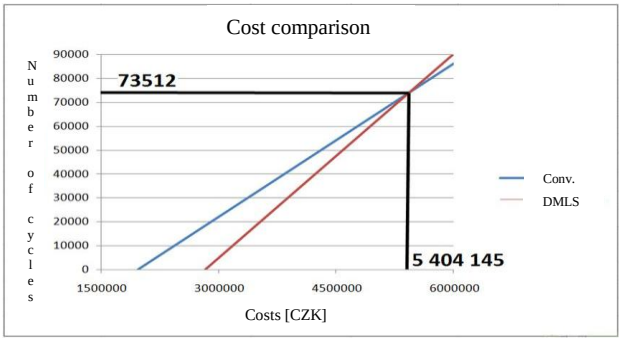


Fig. 5. Cost comparison

3. CONCLUSION

As it was told in previous paragraphs, DMLS is innovative technology which allows us to create shapes and parts which are not possible to create by any other technology.

In this experiment has been compared two cooling systems, one has been created by conventional methods of machining and the second one by using DMLS technology. Both systems have been designed as good as possible, which has allowed us to determine wheter DMLS cooling system will even pay off.

Comparison has been done in Autodesk Moldflow Insight 2011 and results have shown that DMLS cooling system is in this case a better option, but only in considering higher productions.

This research paper has shown that using DMLS technology in injection mold design could be next step in development of injection molding. Further research is recommended because of growing complexity of injected parts.

4. ACKNOWLEDGEMENTS

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