Case Study

Tooling Inserts with Conformal Cooling

ABB reduces cooling and cycle times with additive design optimization

3D-Printing Success Story

INCREASED PRODUCTION QUALITY

less scrap due to optimized cooling

PROCESS OPTIMIZATION

Reduction of cooling and cycle times

Part data

Designation:	Tooling Inserts
Industry:	Tooling
Material:	316L
Layer Thickness:	30 µm
Build Time:	5d 22h 41min (full load, 24 pieces)
Machine:	SLM®280 Twin

SLM®280

Current Situation

New solutions for the tooling industry

Selective Laser Melting, an additive manufacturing technology, can be used for the production of tooling parts with conformal cooling channels. ABB OY, Drives and Controls, was able to tremendously reduce the cycle time for a cabling grommet due to a redesign and optimization of a tooling insert. The optimized part geometry not only reduces the cycle time, but also leads to less scrap parts in production.

ABB produces millions of cabling grommets per year. The cabling grommet, which was used for this case study, is a high volume component made of a thermoplastic elastomer (TPE). The injection molding tool used for production did not have any cooling inserts in the original design and a cycle time of around 60 seconds, including cooling time of the TPE of about 30 seconds.

The aim of implementing conformal cooling for this insert was to improve the efficiency of production and increase the product quality resulting in less defective products.

Innovations with Selective Laser Melting

Redesign for conformal cooling

For the study, six different channel profiles were designed for the tooling insert, including one resembling a part with conventional cooling to provide a comparison to traditional manufacturing. The channel profiles were optimized for the SLM® technology, taking into account factors including the angles of surfaces facing down to reduce the need of supports, minimum wall thickness between channels and the dimensions and shapes of the channels. Before building the various cooling profiles, simulations for water flow and thermal conductivity were carried out, already showing different cooling behavior between the parts.

The tooling inserts were built in six various designs by the Finnish company VTT on an SLM®125 machine in tool steel 1.2709. Heat treatment achieved the desired hardness of 54 HRC and the final outer shape was conventionally machined.

Type 1:
Thin U-profile

- better reach towards the tip
- smaller cross section area
- water flow is entirely closer to the surface

Type 2:
Thick U-profile with turbulent ribs

- large ribs increasíng turbulence
- larger cross section area
- more water volume flow

Type 3:
Slim spiral profile

- smaller pitch
- smaller cross section area
- denser profile
- classic design

Type 4:
Robust spiral profile

- larger pitch
- larger cross section area
- less dense profile
- more water volume flow

Type 5:
Fountain profile

- the largest and the most symmetric and coherent profile
- very experimental design

Type 6:
Conventional »drilled« profile

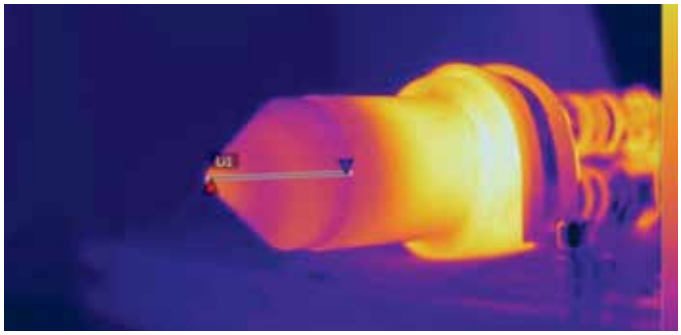
- internationally not optimized design
- represents classic solution which will be compared with optimized versions

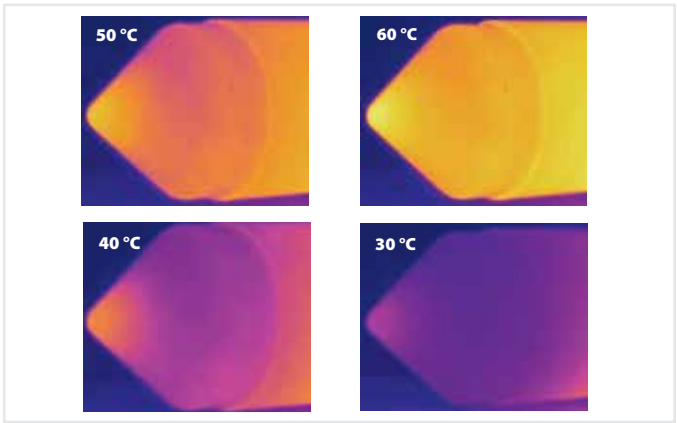
Performance testing

To test the cooling, the parts were heated to a temperature of 70°C with a tempering system and cooled to 20°C to resemble the cooling of the TPE in the injection molding process. The cooling phase was monitored through infrared scanning to compare the cooling behavior.

With cooling times under 10 seconds, the best cooling behavior was obtained from the fountain, thin U and thick spiral profiles. These feature relatively small cross sections for rapid and turbulent water flow, as well as conformal water flow close to the insert surface. The tip area cooled slower on all inserts. The fountain and thin U-profile were identified for the most potential for production with other parameter and ease of manufacturability considerations.

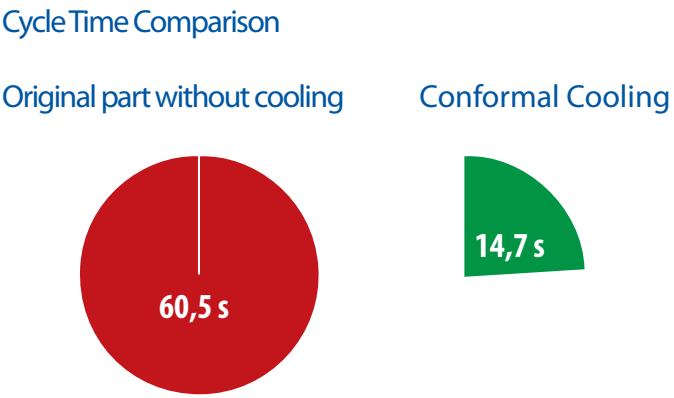
The parts with conformal cooling were used in the injection molding tool and no evident insert-dependent performance differences between the cavities could be found. A cooling time of the TPE of approximately six seconds was achieved, resulting in a cycle time of 14.7 seconds.





Conformal cooling for high volume injection molding components

The utilization of the SLM® technology led to drastic reduction of cycle time and production cost. Achieving a shortened cooling time of approximately six seconds by using the conformal cooling insert in the injection molding tool, down from around 30 seconds, reduced the cycle time from 60.5 seconds to 14.7 seconds.



Summary

Conformal Cooling for Tooling Inserts

- Tooling insert is equipped with conformal cooling channels
- Cooling time of TPE is reduced 80% compared to original insert
- Complete cycle time is over 75% shorter than with original insert
- Fewer defective products due to more equal cooling on the surface

ABB Oy, Drives and Controls

ABB is a global leader in power and automation technologies. Based in Zurich, Switzerland, the company employs 145,000 people and operates in approximately 100 countries. In Finland, the number of people working for ABB is around 5,400. The firm's shares are traded on the stock exchanges of Zurich, Stockholm and New York.

Drives and Controls is the world's leading manufacturer of drives and PLCs. It employs around 6,600 people in more than 80 countries. It has 12 factories to ensure customer needs around the world.++

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SLM Solutions - Technology Pioneers, Innovation Leaders

SLM Solutions helped invent the laser powder bed fusion process, was the first to offer multi-laser systems and all selective laser melting machines offer patented quality, safety and productivity features. Taking a vested interest in customers' long-term success in metal additive manufacturing, SLM Solutions' experts work with customers at each stage of the process to provide support and knowledge-sharing that elevate use of the technology and ensure customers' return on investment is maximized. Optimal paired with SLM Solutions' software, powder and quality assurance products, the SLM® technology opens new geometric freedoms that can enable lightweight construction, integrate internal cooling channels or decrease time to market.

A publicly traded company, SLM Solutions Group AG focuses exclusively on metal additive manufacturing and is headquartered in Germany with offices in China, France, India, Italy, Russia, Singapore and the United States and a network of global sales partners.





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