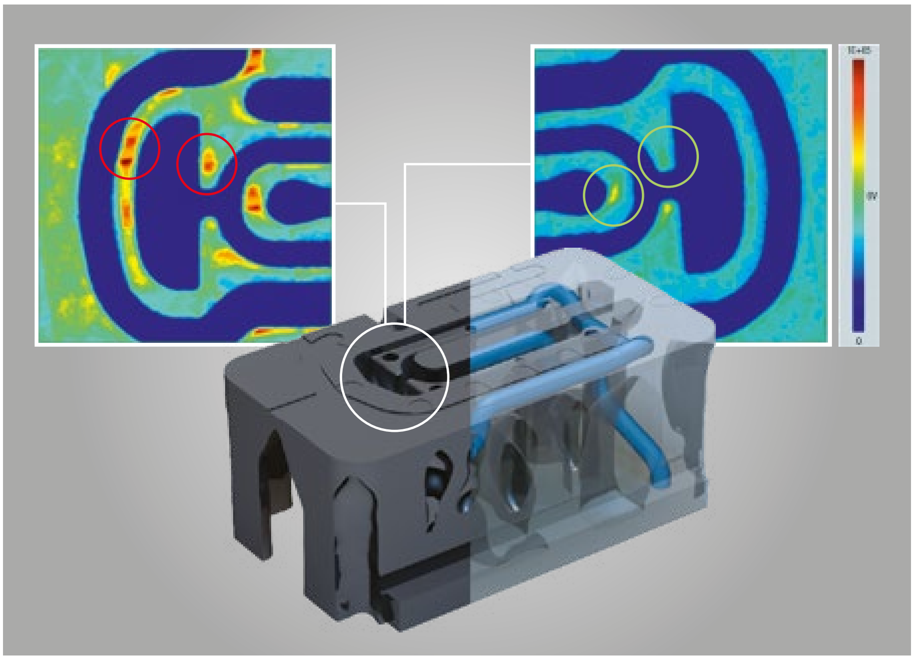
Success Story
Tooling

voestalpine
ONE STEP AHEAD.

Shorter Time to Market for AM Tooling Inserts with EOSTATE Monitoring Solutions

Source: voestalpine Additive Manufacturing Center GmbH



Digital representation of the process behavior measured by EOSTATE Exposure OT before (red marked positions, left) and after parameter optimization (green marked position, right)

Challenge

- Both design and printing parameters need to be optimized in order to meet each unique customer's requirements
- Anomalies can hamper the repeatability and precision of the AM process which can directly affect the performance of the printed parts
- Extensive quality assurance testing is needed after the parts are printed

Solution

- EOSTATE monitoring solutions give insights into process behavior enabling digital detection of anomalies during printing
- Expertise to optimize design and printing parameters

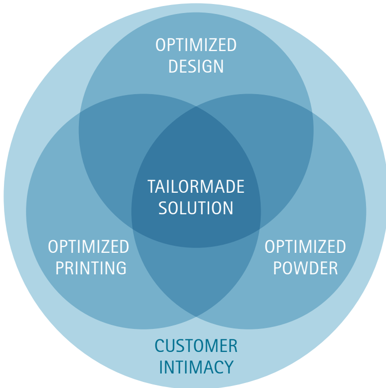
Results

- Faster development of process parameters
- Reduction of printing costs due to fewer job iterations
- Reduction of quality assurance costs

eos

Development of Printing Parameters
Optimized for High-Performance PIM Materials

Thanks to voestalpine´s experience and position as a global leader in the manufacture and supply of tool steel, voestalpine is aware of the challenges faced by customers in the plastic injection molding (PIM) industry. It is the high level of customer intimacy and technological familiarity that enables voestalpine to develop tailor-made solutions based on its three-pillar approach. This is why voestalpine's PIM customers enjoy significant improvements in performance across multiple applications in terms of inserts, sliders, filters, and mixers. Manufactured with the EOS M 290 machine and optimized with EOS monitoring solutions, voestalpine has supplied tailor-made tooling inserts for such partners as Eisenhuth and ARTC Singapore, as well as other industrial companies in the field of PIM applications.



voestalpine's three pillar approach: optimized powder, optimized design and optimized printing.

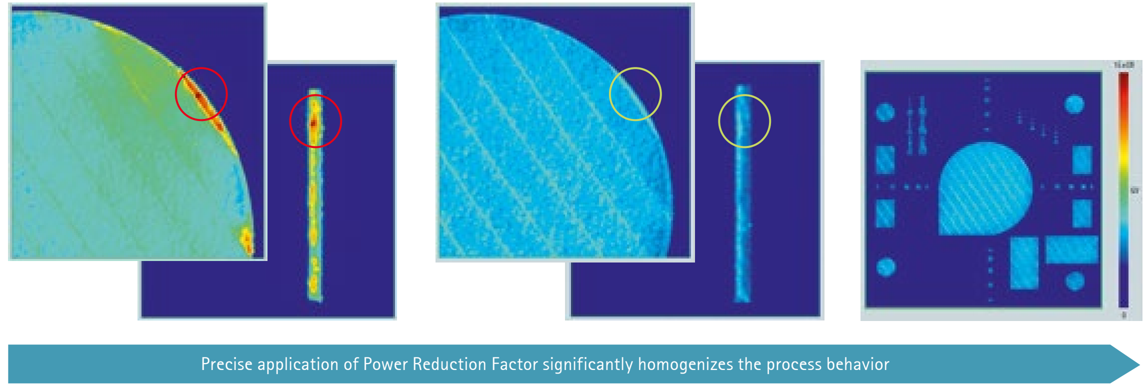
Challenge

With conventional tooling inserts, line-of-sight cooling often results in a non-homogeneous cooling profile around the molded part. If the thermal profile over such areas is not properly managed, it will lead to part warpage and an increase in scrap rates. When it comes to constructing a conformal cooling channel, additive manufacturing (AM) has proven to be the best solution. However, with the experience gathered by voestalpine in working with AM, the company is aware that quick application specific optimization of the process also involves many challenges. When optimizing printing process parameters, various anomalies can occur if inappropriate settings are applied. These anomalies can hamper the repeatability and precision of the process, directly affecting the properties of the additively manufactured tooling insert. In such areas, inappropriate scan strategies arising from higher input power or incorrect scan patterns lead to excessive energy input, which reduces the flow viscosity of the molten metal and increases the probability of oxidation. The reduction in solid-liquid wettability results in protruding surface features, which in turn gives rise to local deformations. In extreme cases, ball-like features can form on the surface that can increase residual stress, which manifests itself in the form of part distortion. A second source of irregularity is the uncontrolled deposition of process by-products, which can occur with inappropriate process parameter settings. The impingement of the laser on the powder bed during the process results in a high vapor pressure building up during vaporization. The momentum this produces is sufficient to eject molten particles from the surface of the powder bed. The inert gas flow also causes powder particles to fly off the powder bed. When using optimized process parameters in production in conjunction with a properly finalized design, orientation and position of the parts, these process by-products are successfully removed by the inert gas flow. However, inappropriate exposure parameters and gas flow settings during process and optimization can lead to uncontrolled by-product deposition, adversely affecting both the final surface quality and the mechanical properties of the additively manufactured part. Generally, an iterative approach is employed, which consists of printing the parts, conducting an extensive laboratory analysis of their properties, and testing and adapting the process parameters. This approach, however, involves laboratory analysis, which is both time-consuming and costly.

Short Profile

voestalpine is a leading global steel and technology group with around 500 affiliated companies and locations in at least 50 countries, employing a total of around 49 000 people. Its top-quality products and system solutions make it a leading partner for automotive and consumer goods, aerospace and the oil and gas industries. It is the world market leader in railway systems, tool steel, and special sections.

Further information
www.voestalpine.com/additive



Validation of process parameters with EOSTATE Exposure OT based on a test matrix before and after optimization (Source: voestalpine Additive Manufacturing Center GmbH)

Solution

To address this challenge, voestalpine chose to produce AM tool inserts with conformal cooling using EOS M 290 manufacturing systems. To increase the cooling efficiency of the circuit, the diameters of the channel were increased to a minimum of 5 mm. The material selected was Uddeholm Corrax for AM or BÖHLER M789 AMPO, as it is known to exhibit superior corrosion resistance and is ideal for mold making. To obtain the desired combination of properties, design and performance, it was necessary to perform multiple build jobs and subject them to metallographic analysis and mechanical testing. The results were then correlated with the data obtained with EOSTATE monitoring solutions. EOSTATE Exposure OT and EOSTATE MeltPool Monitoring enable real-time signal monitoring, which reveals the formation of any local defects. For example, the monitoring analysis showed that areas subject to potential overheating due to high energy input occur around the geometrical contours and at zones involving short tracks in the scan pattern. In manufactured parts, areas with insufficient thickness are prone to such anomalies, as can be inferred from the monitoring system. Measures derived from the results of the analysis can then be taken to optimize the energy input dynamically to the part geometry by lowering the laser's input power during the printing process.

Results

Using EOSTATE Exposure OT made it possible to reduce the number of iterative build jobs that would otherwise have been necessary to develop and fine-tune the process parameters. This lowered the printing and lab costs, which in turn increased the overall return on investment in the development of PIM molds for AM processing. The use of inserts produced by AM meant that customers could now benefit from significant improvements in both cycle times and product quality. The optimized topology further reduced the overall mass of the tool as well as lowering printing costs. Homogenized process behavior was achieved by precise application of the power reduction factor, resulting in enhanced part quality. Moreover, the layer thickness of the AM inserts was increased from 30 to 60 µm, which doubled the build rate and lowered lead times for production.

> "EOSTATE Exposure OT and MeltPool Monitoring gave us a deeper understanding of the interactions taking place between the various factors that influence the LPBF process. Not only were we able to minimize the development cycles of novel materials during the qualification phase but we were also able to benefit from faster build rates and lower lead times for production."

Witalij Gridin
Team Leader for Process Development

Headquarters

EOS GmbH
Electro Optical Systems
Robert-Stirling-Ring 1
D-82152 Krailling/Munich
Germany
Phone +49 89 893 36-0
info@eos.info

www.eos.info
EOS
EOSGmbH
EOS.global
EOSGmbH
#ResponsibleManufacturing

Further Offices

EOS France
Phone +33 437 497 676

EOS Greater China
Phone +86 21 602 307 00

EOS India
Phone +91 443 964 8000

EOS Italy
Phone +39 023 340 1659

EOS Japan
Phone +81 45 670 0250

EOS Korea
Phone +82 2 6330 5800

EOS Nordic & Baltic
Phone +46 31 760 4640

EOS North America
Phone +1 877 388 7916

EOS Singapore
Phone +65 6430 0463

EOS UK
Phone +44 1926 675 110