FROM CONCEPT TO COMPONENT

Additive Manufacturing
The next dimension in HPDC tooling

voestalpine Additive Manufacturing
www.voestalpine.com/additive

voestalpine
ONE STEP AHEAD.

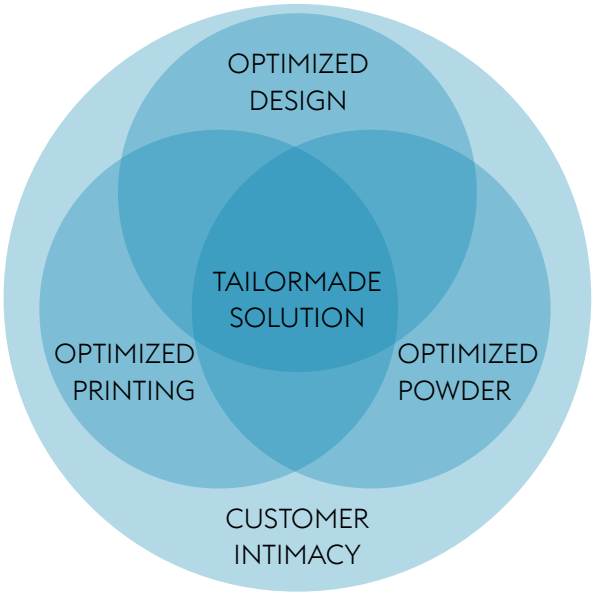
ADDITIVE MANUFACTURING
THE NEXT DIMENSION IN HPDC TOOLING

For decades we have been recognised as a global leader in the manufacture and the supply of tool steel, as a result we understand the challenges that our customers face in the high-pressure die casting industry. Customer intimacy and technical understanding is a major factor when developing successful solutions with our partners.

Our attention to detail goes far beyond the design of the tool. Our additive manufacturing experts develop printing parameters specifically optimized to suit our range of high performance HPDC materials, giving our customers unique solutions with superior results.

Unique tools require unique solutions. Working together with our customers, using our state-of-the-art additive manufacturing and materials know how, we develop tailor-made AM solutions optimized specifically for high-pressure die casting.

Your trusted AM partner



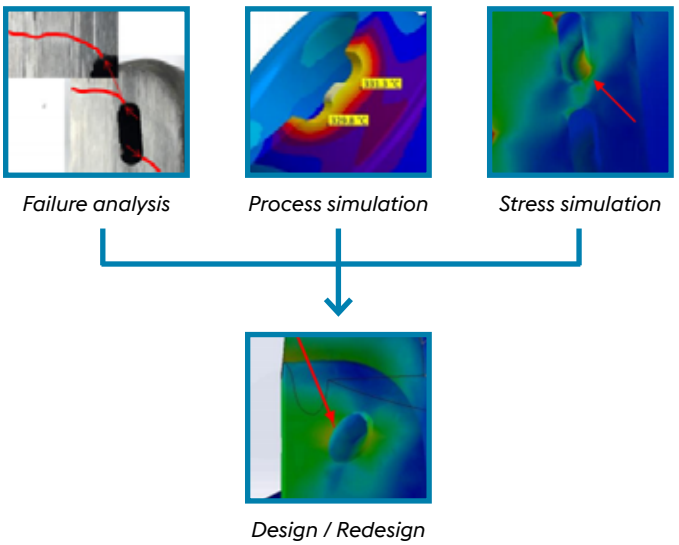
Three-Pillar Approach: Optimized Powder, Design and Printing.

OPTIMIZED
DESIGN

AM expertise paired with extensive HPDC know-how ensures we deliver the best possible tooling solutions to our customers. We support our customers through a detailed consultation process to develop the right solution for the right application, using state-of-the-art tools to support the manufacturing process from initial concept to functional parts. Where needed our HPDC experts can help our customers re-design tools according to the exact requirements of their application.

Our data driven approach to cooling channel design analyses processing parameters and mechanical loads to develop detailed computer models and process simulations. This method of optimising thermal management is essential to ensure the right balance between efficient cooling and the mechanical performance of the tool.

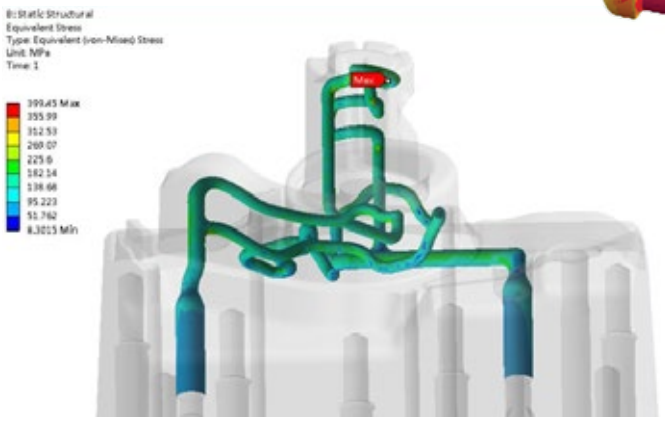
This process goes far beyond regular conformal cooling channel design. We understand HPDC.



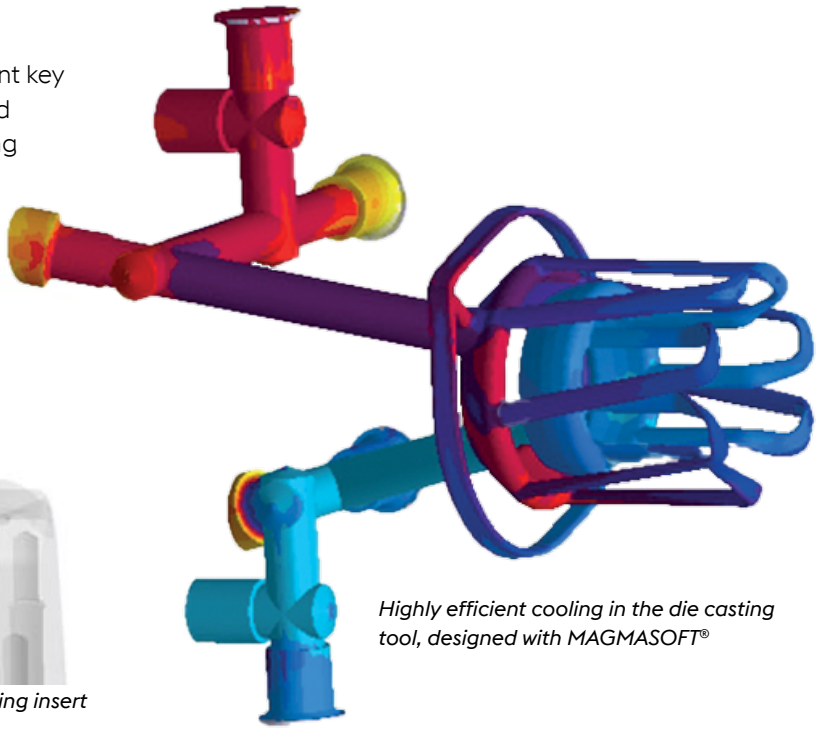
Failure analysis, process & stress simulation are the base to optimize cooling channels

OPTIMIZED DESIGN

Failure analysis and process simulation are important key competences. When paired with our AM design and processing know how, we gain a deep understanding of not only the challenges, but how we can best optimise the part in relation to the performance needs of the customer.



Stress analysis of an optimized high pressure die casting tooling insert

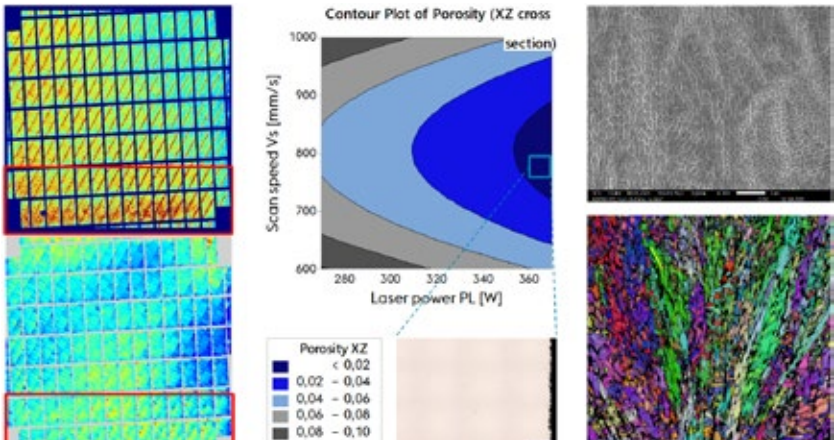


Highly efficient cooling in the die casting tool, designed with MAGMASOFT®

OPTIMIZED PRINTING

We ensure the highest possible quality, reliability and consistency by managing every step of the value chain from powder production to the delivery of the finished part. Whether for a single part order or series production, our internal quality systems ensure we meet your requirements every time. We use state-of-the-art tools to continually improve and refine our internal printing processes. Design of Experiments, Statistical Process Control, and Process Monitoring form the basis of our methodology. Continued innovation from our AM and materials groups ensures we deliver superior material properties in the most demanding applications. As a result, our customers can put parts into service with the highest degree of confidence.

We understand the interactions between laser and material. This deep understanding of AM and HPDC allows customers to add value to their business and realise competitive advantage.



Left: *Optimization goal "build zone" detected by process monitoring using EOSTATE Exposure OT (top) and EOSTATE MeltPool (below).*

Middle: *Design of Experiments for parameter optimization using contour map of response surface design for porosity (top) and the related metallographic sample after optimization (below).*

Right: *Microstructure of AM processed H13-type analyzed by SEM (top) and EBSD (below).*

OPTIMIZED POWDER

BÖHLER W360 AMPO[1]

Our long history of developing materials for the HPDC industry, means the powders we use are of the highest quality and deliver superior tool life. BÖHLER W360 AMPO is our premium grade for HPDC applications. This proprietary grade has been designed to outperform many traditional tool steels such as 1.2709 (Maraging 300), 1.2343 ESR (H11) and 1.2344 ESR (H13).

IN SHORT

- Superior hot wear resistance
- High temper back resistance
- Recommended hardness in use 50 -56 HRC
- Designed for high demanding tooling applications like HPDC and reinforced plastics

COMPARISON WITH TYPICAL FORGED HOT WORK TOOL STEELS

Material	Hot temp. toughness	Hot temp. wear resistance
1.2343	★★★★½	★★
1.2344	★★★	★★★
1.2709	★★★	★½
BÖHLER W360 AMPO	★★★★	★★★★★

CHEMICAL COMPOSITION[1]

Elements[1]	C	Si	Mn	Cr	Mo	V	Fe
[wt.%]	0.50	0.20	0.25	4.50	3.00	0.55	Bal.

PROCESS DATA

Build chamber size
Ø290 x 370 mm³

MECHANICAL PROPERTIES

Based on our own optimized printing parameters we can ensure superior mechanical properties of the printed parts

Properties[2]	Tensile strength[3] [MPa]	Yield strength[3] [MPa]	Elongation at break[3] [%]	Notch impact energy[4] [J]
50-52 HRC[5]	1500 - 1650	1200 - 1400	5.5 - 8	15 - 20
54-56 HRC[5]	2000 - 2100	1600 - 1800	4 - 6	10 - 12

Working closely with an independent research centre* we tested the performance of different tool steels widely used in HPDC applications. Several tests were performed to establish the behaviour and suitability of these materials in HPDC applications. The materials tested:

- Maraging Steel – 1.2709
- HPDC Tool Steel – 1.2343 ESR / H11
- Premium Tool Steel – BÖHLER W360 AMPO

*The Austrian Foundry Research Institute (ÖGI Austria) is accredited as a testing laboratory in accordance with the Austrian Accreditation Law.

1. BÖHLER W360 AMPO is a brand of voestalpine Böhler Edelstahl GmbH & Co KG. The chemical composition & processing is protected by registered intellectual property rights.
2. All mechanical properties measured were from specimens with a relative density ~99.9%
3. Tensile test performed according to method DIN EN ISO 6892-1B, specified by VDI 3405 Part 2 at room temperature, the specimens were built according to DIN EN ISO 50125;
4. Charpy V-notch test according to DIN EN ISO 148-1 at 20°C;
5. Hardness test performed according to DIN EN ISO 6508-1

OPTIMIZED POWDER

UDDEHOLM DIEVAR® FOR AM[1]

Uddeholm Dievar® for AM is a high performance chromium-molybdenum-vanadium alloyed hot work tool steel which offers very good resistance to heat checking, gross cracking, hot wear and plastic deformation. Regardless of the dominant failure mechanism Uddeholm Dievar® for AM offers the potential for significant improvements in die life, and resulting in better tooling economy.

IN SHORT

- Superior toughness level in hardened and tempered condition
- High temper resistance
- High temperature strength
- Superior polishability
- Recommended hardness in use 46 - 48 HRC
- Designed for high demanding tooling applications like HPDC and plastic injection molding

COMPARISON WITH TYPICAL FORGED HOT WORK TOOL STEELS

Material	Hot temp. toughness	Hot temp. wear resistance
1.2343	★★★★½	★★
1.2344	★★★	★★★
1.2709	★★★	★½
Uddeholm Dievar® for AM	★★★★★	★★★

CHEMICAL COMPOSITION[1]

Elements[1]	C	Si	Mn	Cr	Mo	V
[wt.%]	0.35	0.2	0.5	5.0	2.3	0.6

PROCESS DATA

Build chamber size
400 x 400 x 400 mm^3

MECHANICAL PROPERTIES

Based on our own optimized printing parameters we can ensure superior mechanical properties of the printed parts

Properties[2]	Tensile strength[3] [MPa]	Yield strength[3] [MPa]	Elongation at break[3] [%]	Notch impact energy[4] [J]
46-48 HRC[5]	1500 – 1550	1250 – 1350	13 – 15	42 – 48

Working closely with an independent research centre* we tested the performance of different tool steels widely used in HPDC applications. Several tests were performed to establish the behaviour and suitability of these materials in HPDC applications. The materials tested:

- Maraging Steel – 1.2709
- HPDC Tool Steel – 1.2343 ESR / H11
- Premium Tool Steel – Uddeholm Dievar® for AM

*The Austrian Foundry Research Institute (ÖGI Austria) is accredited as a testing laboratory in accordance with the Austrian Accreditation Law.

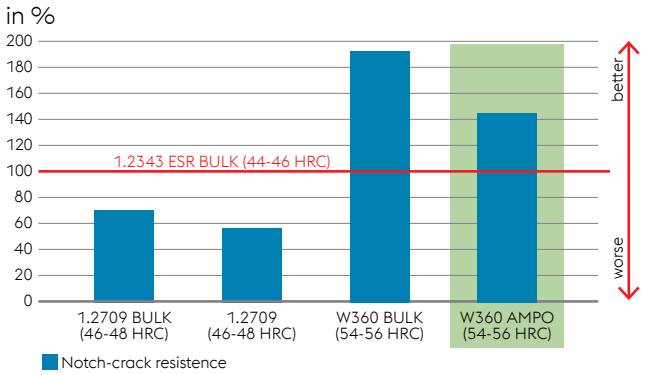
1. Uddeholm Dievar® for AM is a brand of Uddeholms AB. The chemical composition & processing is protected by registered intellectual property rights.
2. All mechanical properties measured were from specimens with a relative density ~99.9%
3. Tensile test performed according to method DIN EN ISO 6892-1B, specified by VDI 3405 Part 2 at room temperature, the specimens were built according to DIN EN ISO 50125;
4. Charpy V-notch test according to DIN EN ISO 148-1 at 20°C;
5. Hardness test performed according to DIN EN ISO 6508-1

OPTIMIZED POWDER

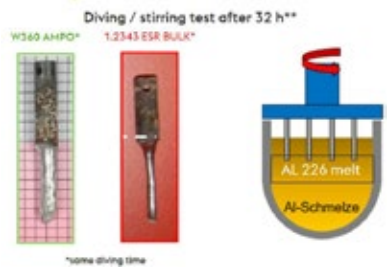
We tested the bulk samples of the materials and compared them to the 3D printed BÖHLER W360 AMPO and Uddeholm Dievar® for AM using following testing criteria:

» Thermo-Chemical Resistance (diving / stirring test)
» Crack Resistance
» Heat Checking Resistance

BÖHLER W360 AMPO - Notch-crack resistance



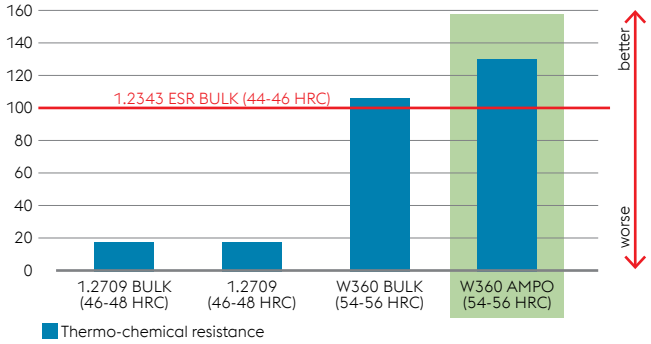
Test Lab ÖGI Austria.



Test bars were put into liquid Aluminum to test the thermo chemical resistance. 32 hours of diving time could be compared to roughly 120.000 shots. This is based on the assumption that 1 shot has 1 second contact time with liquid aluminium.

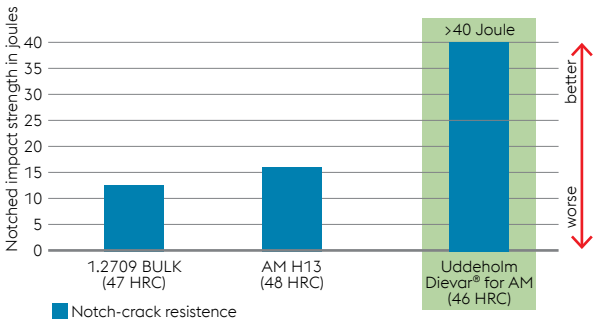
Thermo-chemical resistance

Quantitative Assessment after 32 hours diving/stirring time in %



BÖHLER W360 AMPO displays exceptional performance when compared with traditional tool steels. Its outstanding wear resistance outperforms the various traditional materials.

Uddeholm Dievar® for AM - Notch-crack resistance

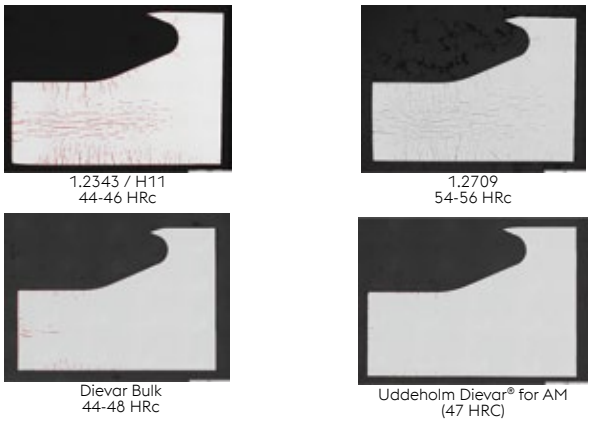


Test Lab ÖGI Austria.

Samples were alternately immersed in liquid aluminium and in a coolant to test the thermal shock resistance. Notch-crack resistance indicates the tendency to break through to the cooling channel, failure due to macroscopic cracks.

Comparison of longitudinal section

The sectional views of the material specimens shown below are intended to illustrate the tendency to form microcracks for the various materials.



Compared to traditional tool steels such as 1.2343 and 1.2709, Dievar specimens exhibit significantly less crack formation. Uddeholm Dievar for AM is characterized by its superior material properties specifically by its exceptional high toughness, which is illustrated with the significantly reduced crack formation.

TAILORMADE SOLUTIONS

OPTIMIZED DESIGN.
OPTIMIZED PRINTING.
OPTIMIZED POWDER.
OPTIMIZED FOR YOU.

Our three-pillared approach to additive manufacturing has shown to deliver significant performance improvements to our HPDC customers across a range of applications, such as sliders, sub-inserts, sprues, and distributors (and distributor rings).

SUB-INSERT

Application: pump housing

» Scrap rate reduction
» Life time improvement

Performance compared to conventional cooled sub-insert:

Life time: >350%

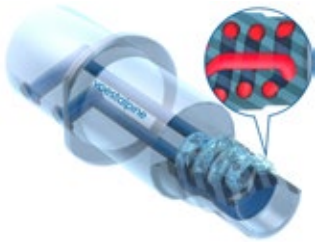
SLIDER

Application: clutch housing

» Scrap rate reduction
» Life time improvement

Performance compared to conventional cooled slider:

Life time: >600%



DISTRIBUTOR

Application: aluminium HPDC

» Cycle time reduction
» Life time improvement

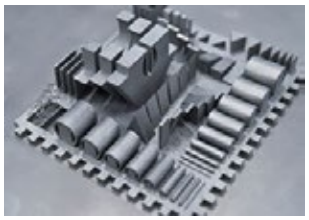
Performance compared to conventional cooled distributor:

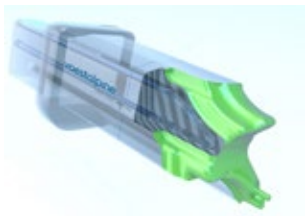
Cycle time: -3 sec | Life time: >150%

FROM CONCEPT TO COMPONENT

As a global steel and technology leader, we offer the full suite of production techniques and services throughout the value chain, supporting and driving innovation and development based on lengthy experience around materials and processing. Starting from the alloy development and metal powder production, to design and manufacturing and including post-processing. We offer the end-to-end solutions to reduce waste and mitigate risk in the supply chain with the goal of being your trusted and reliable business partner. **We deliver tailormade solutions from concept to component.**


Metal Powder

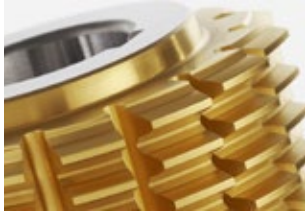

Parameter Development


Design/Simulation


Additive Manufacturing


Heat Treatment


Machining


PVD Coating


Inspection/Testing

voestalpine Additive Manufacturing Center
Hansaallee 321
40549 Düsseldorf, Germany
+49 211 522 2310
additive@voestalpine.com
www.voestalpine.com/additive

voestalpine
ONE STEP AHEAD.

version – 1.2024