Hot Stamping of UHSS Steel and Need for Specialised Tooling
Christoph Mueller
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Kind & Co., Edelstahlwerk, GmbH & Co. KG

Melting Remelting  →  Forging  →  Heat Treatment  →  Vacuum Hardening  →  Warehouse  →  Machining

S E R V I C E

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Motivation

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Motivation:

- Economic and legal requirements to reduce exhaust gas emissions
- Reduction of car weight by 100 kg
  => Reduction of fuel consumption by 0.3 – 0.5 l / 100 km
- Different strategies are developed based on forging, die casting, extrusion and hot stamping
- Decisive is economic efficiency of the produced part
  => Only possible with smoothly operating tools with good durability
The Hot Stamping Process

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The Hot Stamping Process

- Cutting blanks
- Heating blanks to 900 - 950 °C
- Shaping of sheets and quenching in cooled tools
- Trimming

Steel grade: 22MnB5 (1.5528)
- Austenitization temperature: 920 - 950 °C
- $M_s$ temperature: 390 °C
- $M_f$ temperature: 280 °C
- Min. quenching rate: 30 K/sec
Hot Stamping – Impacts on the Tools

Impacts:
- High temperature in contact zone tool ⇔ sheet
- Compression stresses
- Thermal cycles
- Abrasive as well as adhesive wear

General requirements:
- Suitable high-temperature strength
- High thermal fatigue resistance
- High hardness and tempering resistance
- High abrasive wear resistance
- High toughness and ductility
- Thermal conductivity
Development of Tools for Hot-Stamping Applications

Constant change in design from straightforward design to rather complex due to

- Segmented tools
- Cooling channels closer to the surface increasing the heat transport
Suitable Hot Work Tool Steels

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**Improved Productivity by Reducing Wear**

**Kind & Co. CR7V-L**
„The Wear Resistant One“

<table>
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<tr>
<th>Steel Designation</th>
<th>Brand</th>
<th>Mat.-No.</th>
<th>AISI</th>
<th>Mass Content in %</th>
<th>Hardness Recommendation</th>
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<td>CR7V-L</td>
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<td><strong>0.42</strong></td>
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The tempering diagram shows that among the three grades CR7V-L develops the highest achievable hardness combined with an excellent tempering resistance.
Standardized with 1.2367, the abrasive resistance of CR7V-L outperforms the other grades.
Industrial Experience

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Hot Stamping – Industrial Experience

Water leakage from cooling channels

Favoured by critical trends in the industry:
• Using highest hardness for the tools to reduce abrasive wear
• Reduced distances between cooling channels and working surface
Hot Stamping – Corrosion Induced Tool Failure

- Severe corrosion in the cooling channels and
- corrosion induced cracks from cooling channels to working surface
Hot Stamping – Corrosion Types in Hot Stamping Tools

General corrosion

Localized corrosion
Mostly at local inhomogenities or non-metallic inclusions

Corrosion induced cracking
Hot Stamping – Corrosion in Hot Stamping Tools

Range of highest corrosivity due to chromium depleted zones surrounding growing chromium carbides

Hot Stamping – Corrosion Induced Tool Failure

- Severe corrosion in the cooling channels and
- Corrosion induced cracks from cooling channels to working surface

Derived advice:
- Avoid maximum steel hardness
- Consistently monitor the cooling water quality
- Consider addition of corrosion inhibitors
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Conclusion

• Hot stamping is a modern and effective process to produce steel components with extremely high tensile strength.

• Kind & Co. recommends the special grade CR7V-L for quenched hot-stamping tools as it provides high hardness, wear resistance, and thermal conductivity.

• Kind & Co. recommends to avoid maximum hardness values as this is the condition of lowest toughness and highest sensitive to corrosion. This aspect has to be considered when the design of the tools tends to reduce the distance between cooling channels and working surface.

• An efficient cooling water management is urgently recommended.
Tool Steels for World´s Top Performers

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