



Hot Stamping of UHSS Steel and Need for Specialised Tooling

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- Motivation
- The Hot Stamping Process
- Suitable Hot Work Tool Steels
- Industrial Experience
- Conclusion

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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

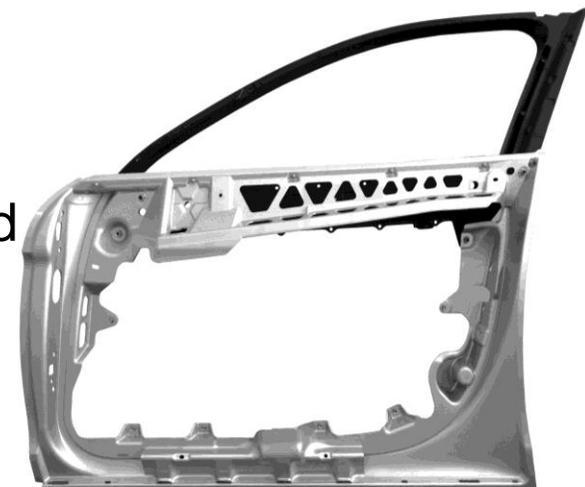
Motivation

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Automotive Light Weight – A Driving Force for Innovation

Motivation:

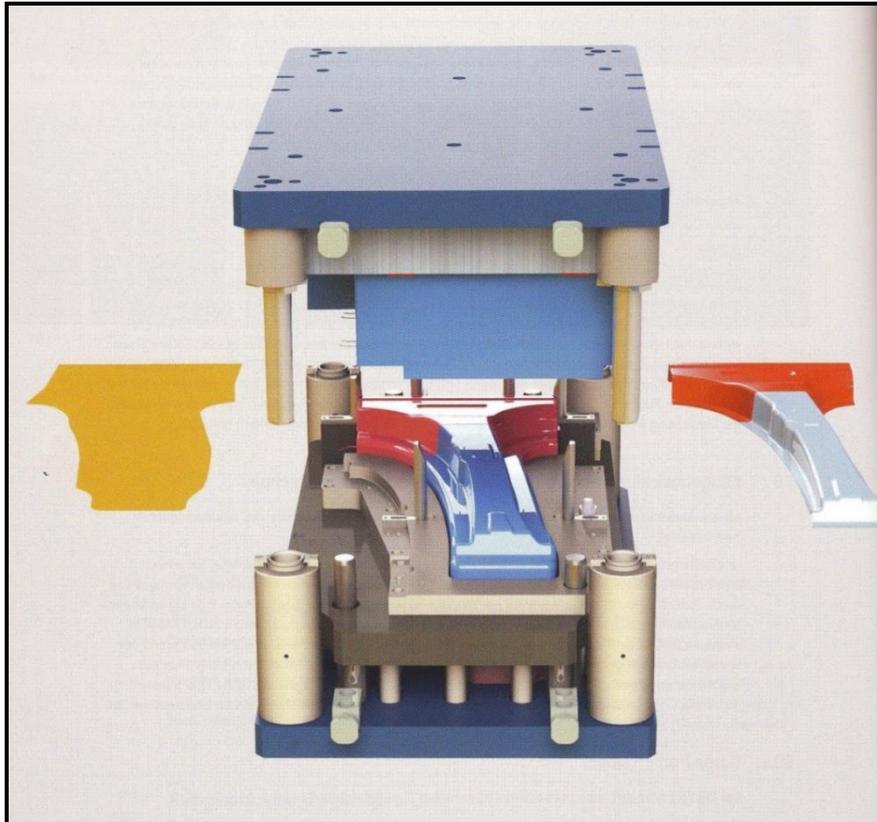
- Economic and legal requirements to reduce exhaust gas emissions
- Reduction of car weight by 100 kg
=> Reduction of fuel consumption by 0.3 – 0.5 l / 100 km
- Different strategies are developed based on forging, die casting, extrusion and hot stamping
- Decisive is economic efficiency of the produced 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

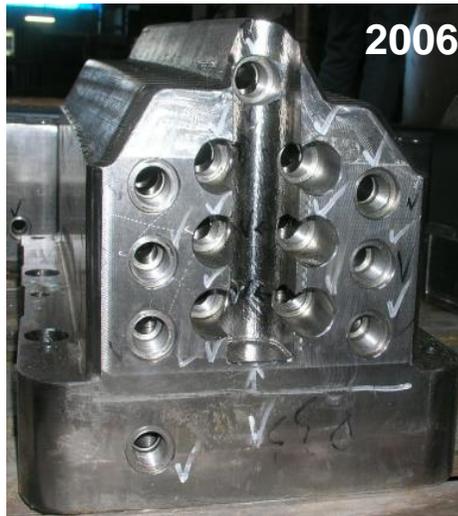
Impacts:

- 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

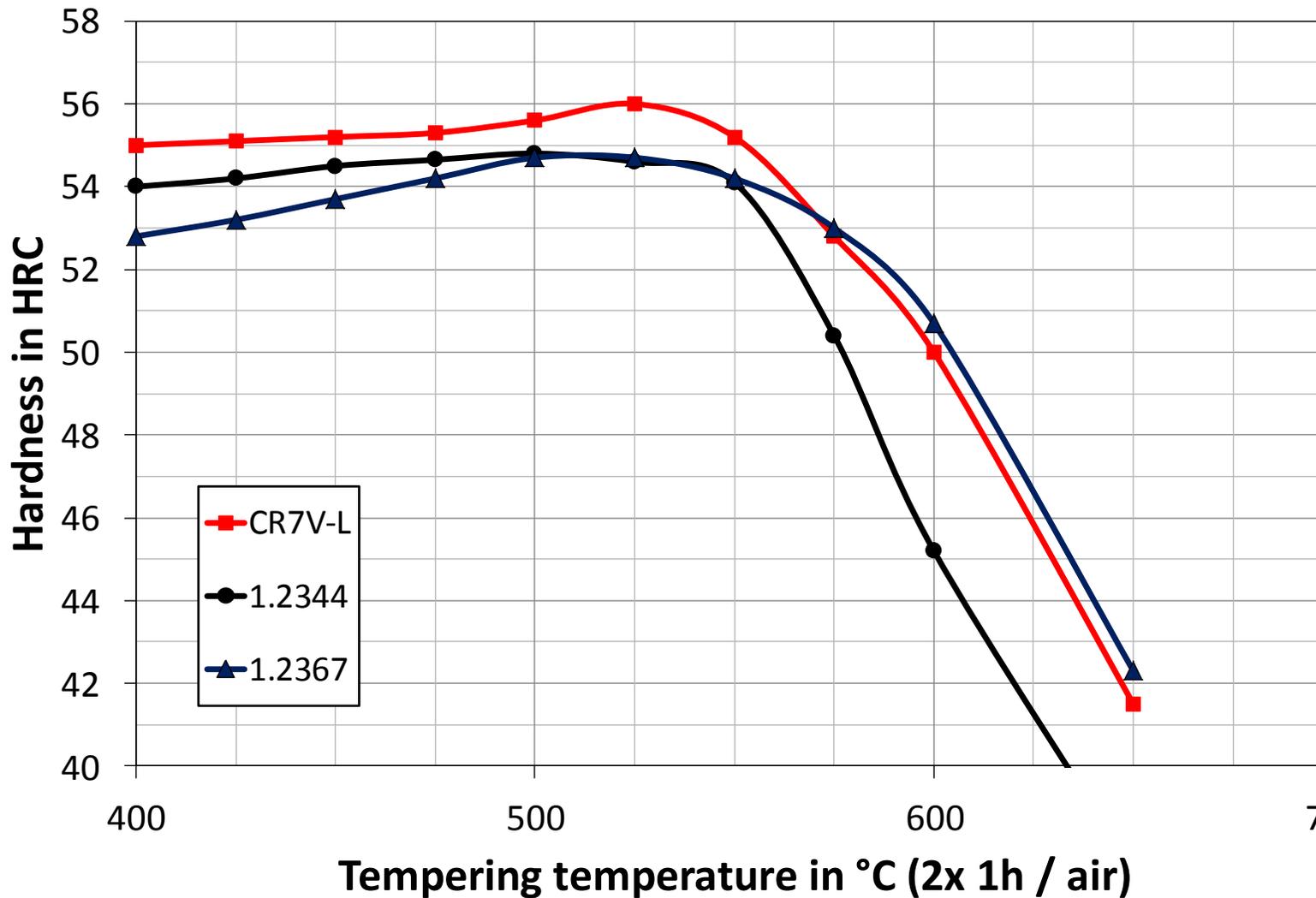
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Improved Productivity by Reducing Wear

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

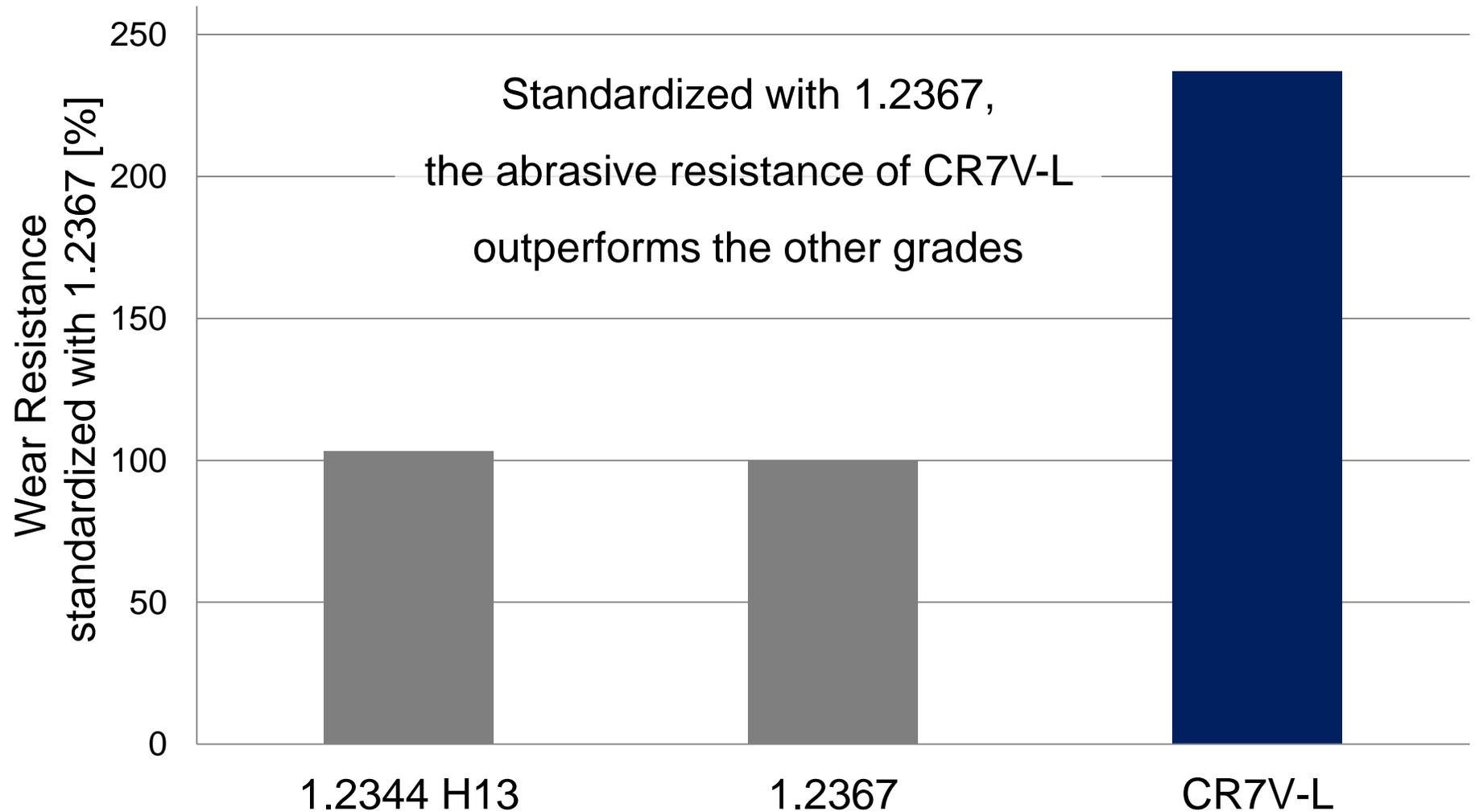
Steel Designation			Mass Content in %						Hardness Recommendation
Brand	Mat.-No.	AISI	C	Si	Mn	Cr	Mo	V	HRC
USD	1.2344	H13	0.40	1.00	0.40	5.20	1.30	1.00	50 – 52
RPU	1.2367	---	0.38	0.40	0.40	5.00	2.80	0.60	50 – 52
CR7V-L	---	---	0.42	0.50	0.40	6.50	1.30	1.00	52 – 54

Hot Stamping – Tempering Behaviour of Suitable Tool Steels



The tempering diagram shows that among the three grades CR7V-L develops the highest achievable hardness combined with an excellent tempering resistance.

CR7V-L Abrasive Resistance Result



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



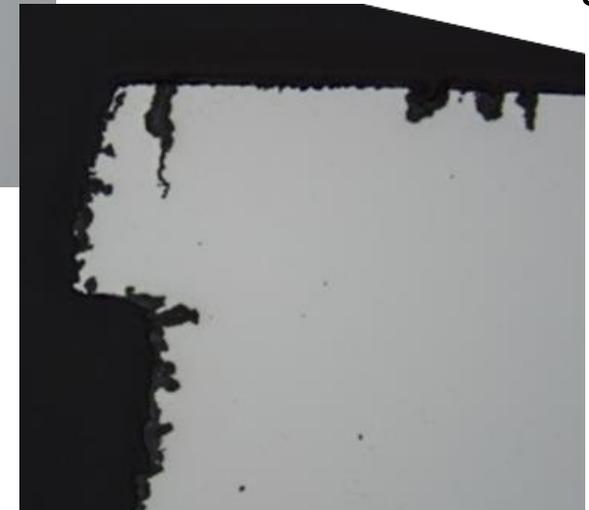
Hot Stamping – Corrosion Types in Hot Stamping Tools



General corrosion

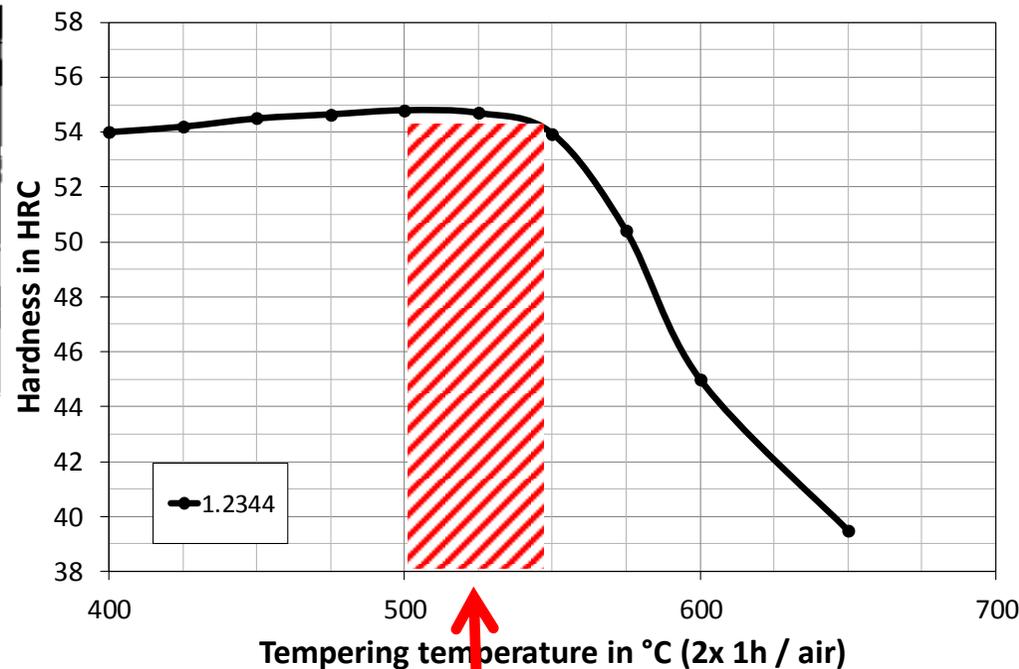
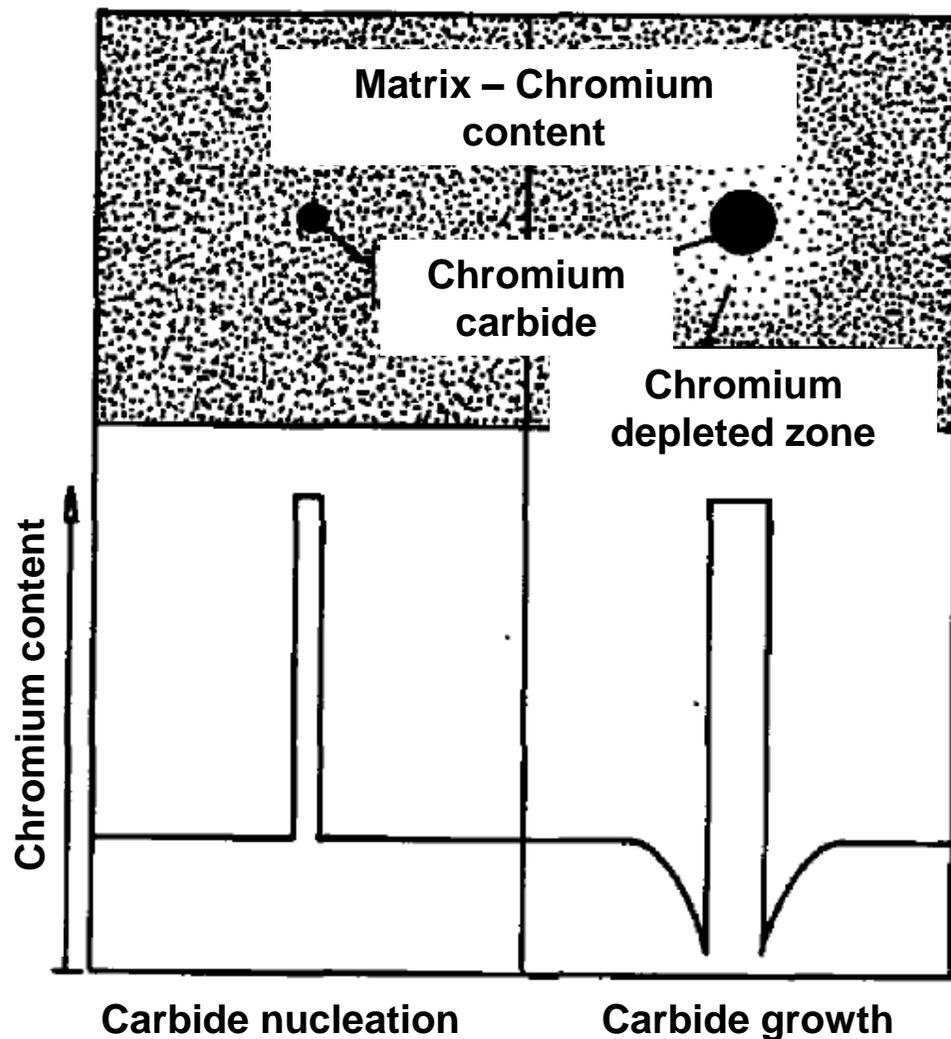


Localized corrosion
Mostly at local
inhomogenities or
non-metallic
inclusions



Corrosion induced
cracking

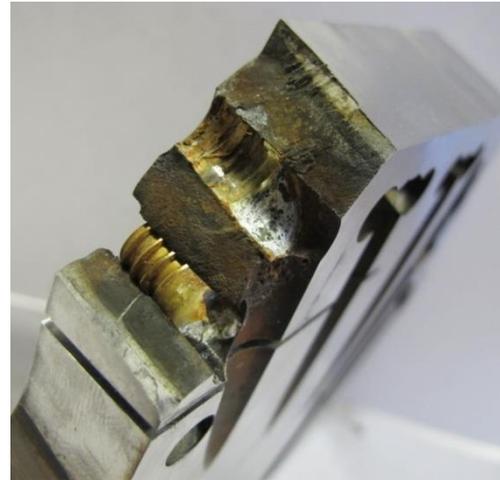
Hot Stamping – Corrosion in Hot Stamping Tools



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

Source:
Arlt, Fleischer, Gebel, Grundmann, Gümpel:
Thyssen Edelst. Techn. Ber. 15 (1989), 1, pp. 1 - 39

Hot Stamping – Corrosion Induced Tool Failure



- Severe corrosion in the cooling channels and
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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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