KIND&CO
EDELSTAHLWERK

Special tool steel solutions for

Forging Dies

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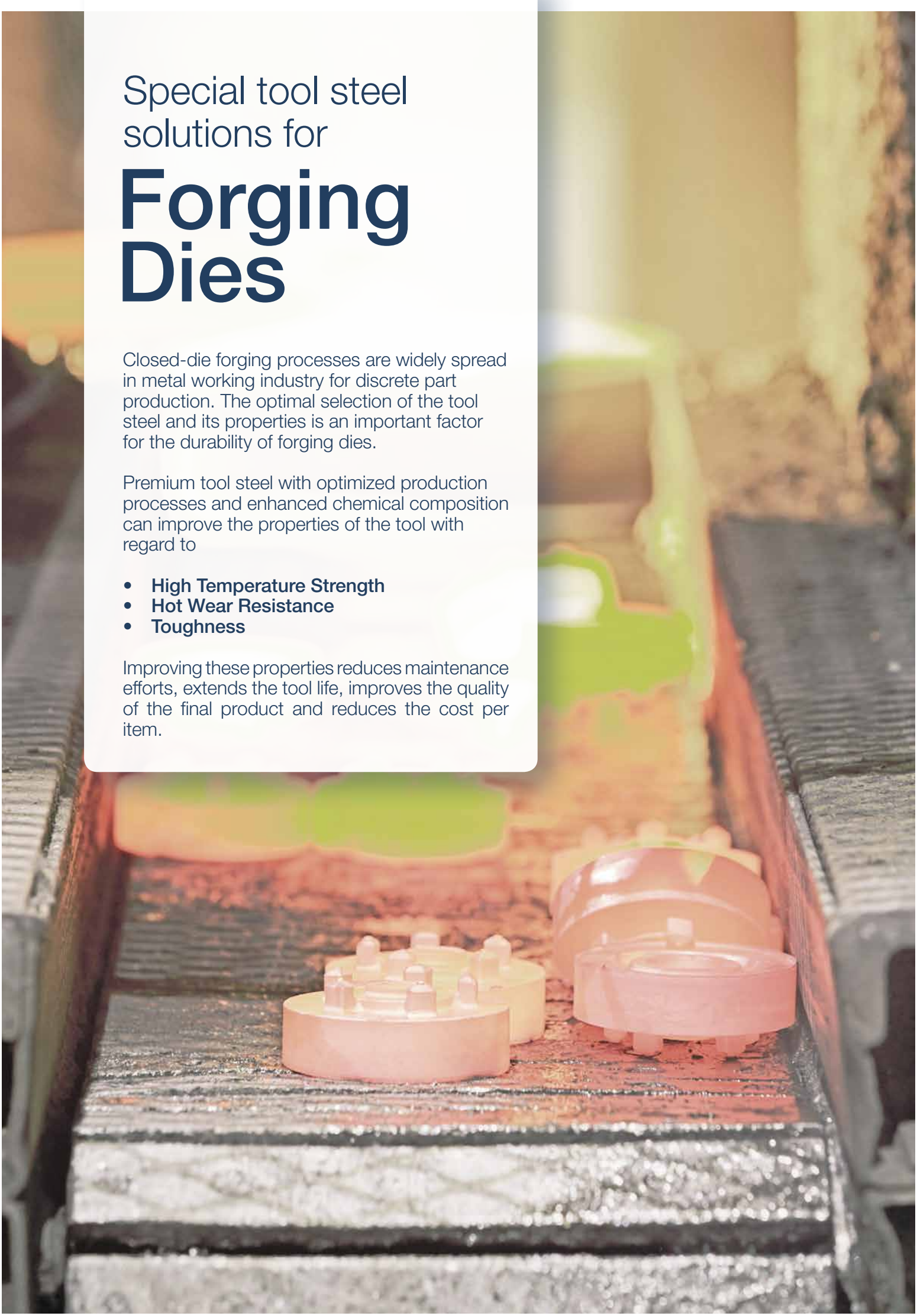
Closed-die forging processes are widely spread in metal working industry for discrete part production. The optimal selection of the tool steel and its properties is an important factor for the durability of forging dies.

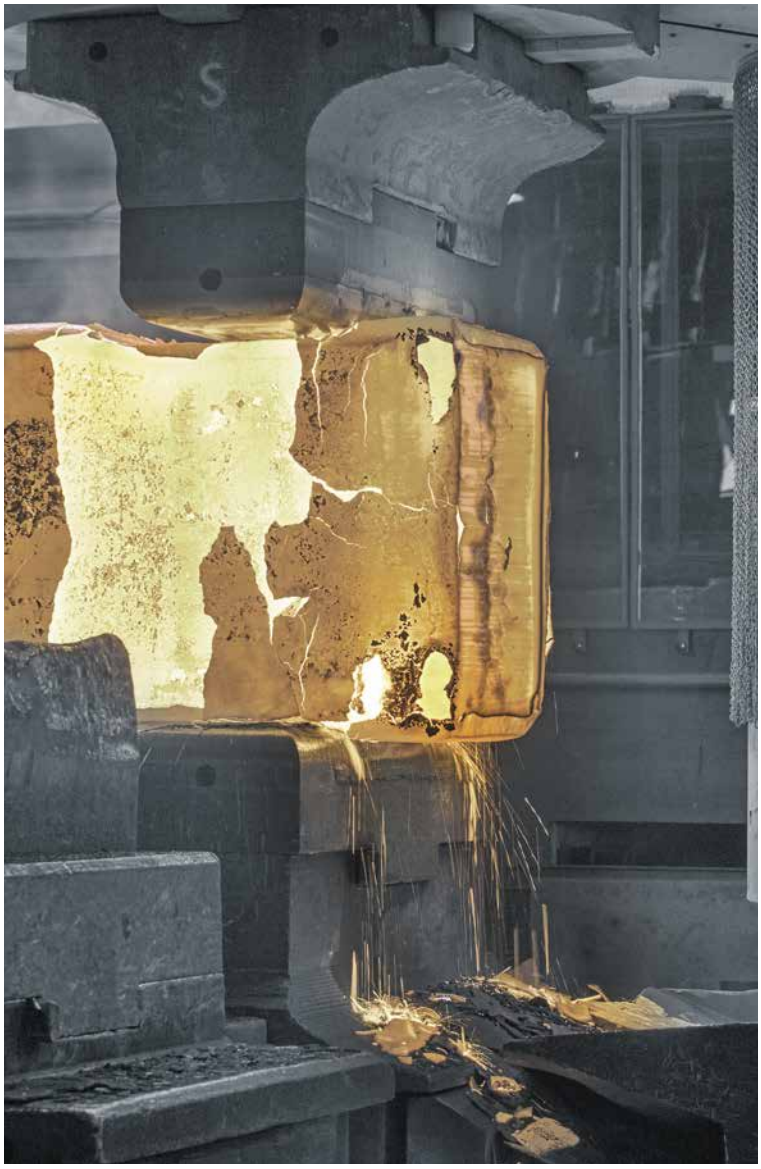
Premium tool steel with optimized production processes and enhanced chemical composition can improve the properties of the tool with regard to

- **High Temperature Strength**
- **Hot Wear Resistance**
- **Toughness**

Improving these properties reduces maintenance efforts, extends the tool life, improves the quality of the final product and reduces the cost per item.



For over 130 years, the development of our company has been shaped by tool steel and its applications. Our many years of experience and our advanced technology and equipment, from primary steel melting to ready-to-use tooling, are the basis of the globally recognized quality of the products from Kind & Co., Edelstahlwerk, GmbH & Co. KG.



Trends in Die Forging

Die Forging is one of the most important processes in the production of serial parts in all areas of our lives. Basic requirements of forgings in all application areas are high dimensional precision and excellent material properties to allow for a long service life, often in safety-critical components

The forging industry is constantly evolving. Due to
- increasingly complex component geometries,
- new production materials, and
- increasing series sizes,

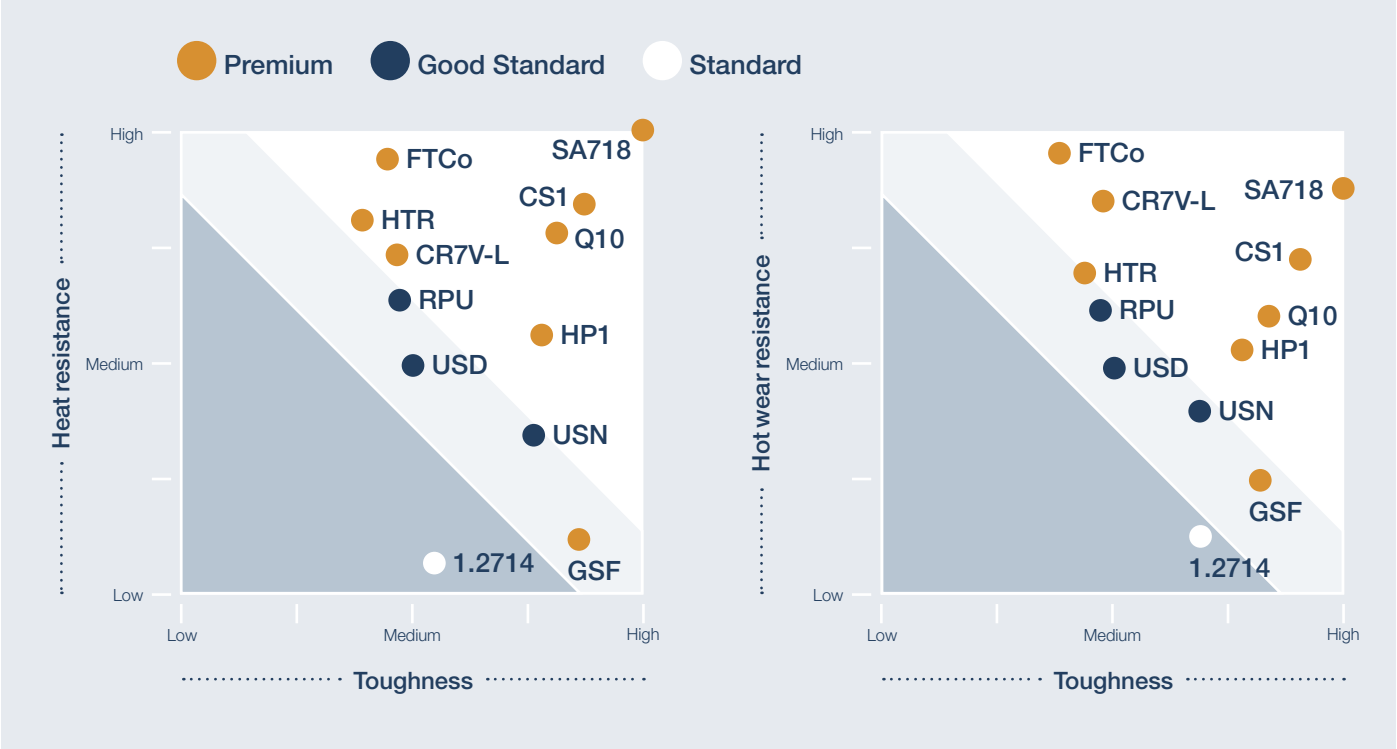
the requirements on forging dies are as well increasing constantly.

In addition to conventional hot forging, more modern forming technologies have increased in importance and today are very economical manufacturing process, especially due to cost savings achieved by near-net or precision warm forming. Precision forgings are mainly used in the key components of aircraft, power generation equipment, tubing components and automotive which have the high requirements on surface quality and security. Titanium and titanium alloys are used today extensively in aerospace and medical applications. Because of their high specific strength, titanium usage results in significant weight reduction. Another advantages include high thermal stability and corrosion resistance.

The presence of high temperature gradients during modern precision forging processes increases the risk for tooling defects. Hot wear, radial cracks and tool breakage are often the consequences.

In order to meet these demanding requirements, our company can offer tailor-made hot work steel, which are able to withstand the severe challenges and to maximize die life. With our deep knowledge and vast experience we supply premium solutions. The use and propper selection of special, tailored tool steel grades is the key to meet the challenges of industrial forging today and beyond.

User-friendly, customised property combinations also cover challenging demands



Good standard: Standardised alloy concept (ISO), but very well executed by KIND & Co. Well balanced material quality, therefore often a good selection for many intended uses.

Premium hot work tool steel with property combinations tailored to meet the intented use with maxium efficiency.

Premium hot work steel with property combinations tailored to meet the necessary intended use

- **CR7V-L** – high wear resistance for dies forging long product series and for high demanding tolerances
- **CS1** – the combination of excellent toughness at high hardness. Ideally suited for warm forging and forging of high temperature resistant alloys
- **FTCo** – excellent tempering resistance and high wear resistance. For high demanding forging mandrels and die forging stems, subjected to high compression, also for forging of Cu and brass alloys
- **HP1** – excellent toughness, for deep impressions or with the tendency of radial cracks . For forging aluminum alloys
- **GSF** – high toughness at improved level of tensile strength, hardened ex mill. For impressions subjected to cracks, especially with intensive mechanical impact
- **SA718** – outstanding high temperature resistance and ductility A Ni base alloy for special applications in drop-stamping like isothermal presses and forming devices of titanium alloys

Tool steel grades – chemical composition

Brand name	AISI	Mass.-%									
		C	Si	Mn	Cr	Mo	Ni	V	Co	W	
GSF	-	0.28	0.30	0.70	2.80	0.60	1.00	0.40	-	-	-
USN	H 11	0.37	1.00	0.40	5.20	1.20	-	0.40	-	-	-
USD	H 13	0.40	1.00	0.40	5.20	1.30	-	1.00	-	-	-
RPU	-	0.38	0.40	0.40	5.00	3.00	-	0.60	-	-	-
HP1	-	0.35	0.20	0.30	5.20	1.40	-	0.55	-	-	Nb +
Q10	-	0.36	0.25	0.40	5.20	1.90	-	0.55	-	-	-
CR7V-L	-	0.42	0.50	0.40	6.50	1.30	-	0.80	-	-	-
HTR	-	0.32	0.20	0.30	2.20	1.20	-	0.50	-	3.80	-
CS1	-	0.50	0.30	0.40	5.00	1.90	-	0.55	-	-	Nb +
FTCo	-	0.53	0.35	0.40	4.00	2.00	-	1.10	0.90	1.50	Nb +
SA718	UNS 7718	0.05	≤ 0.35	≤ 0.35	19.00	3.00	53.00	-	-	-	Al 0.50 Ti 0.90 Nb 5.00 Fe Rest

Requirements for tool steel solution

	Steel	Stainless	Aluminium	Brass	Titanium Cobalt / Chrome	Nickel Based alloys
Hot wear resistance	●●●●○○	●●●●●○	●●○○○○	●●●○○○	●●●●●○	●●●●●●
Tempering resistance	●●●●○○	●●●●○○	●●●○○○	●●●●●○	●●●●●○	●●●●●●
Toughness	●●●●○○	●●●○○○	●●●●●●	●●●○○○	●●●●●●	●●●●●●

The processed material influences the requirements for tool steel as well as the process

Tools		Bar	Single block / or ring	Pre-machined	Pre-machined supplied at working hardness	Manufactured in accordance with drawings, without impression	Processed in accordance with 3D data / drawings
Dies	Round dies	x	x	x	x	x	
	Flat dies	x	x	x	x	x	
Rolling tools	Tapered rolls		x	x	x	x	x
	Main rolls		x	x	x	x	x
	Expanding mandrels		x	x	x	x	x
	Mandrel sleeves		x	x	x	x	x
	Stems		x	x	x	x	x
	Forging rolls		x	x	x	x	
	Cross wedge rolls		x	x	x	x	

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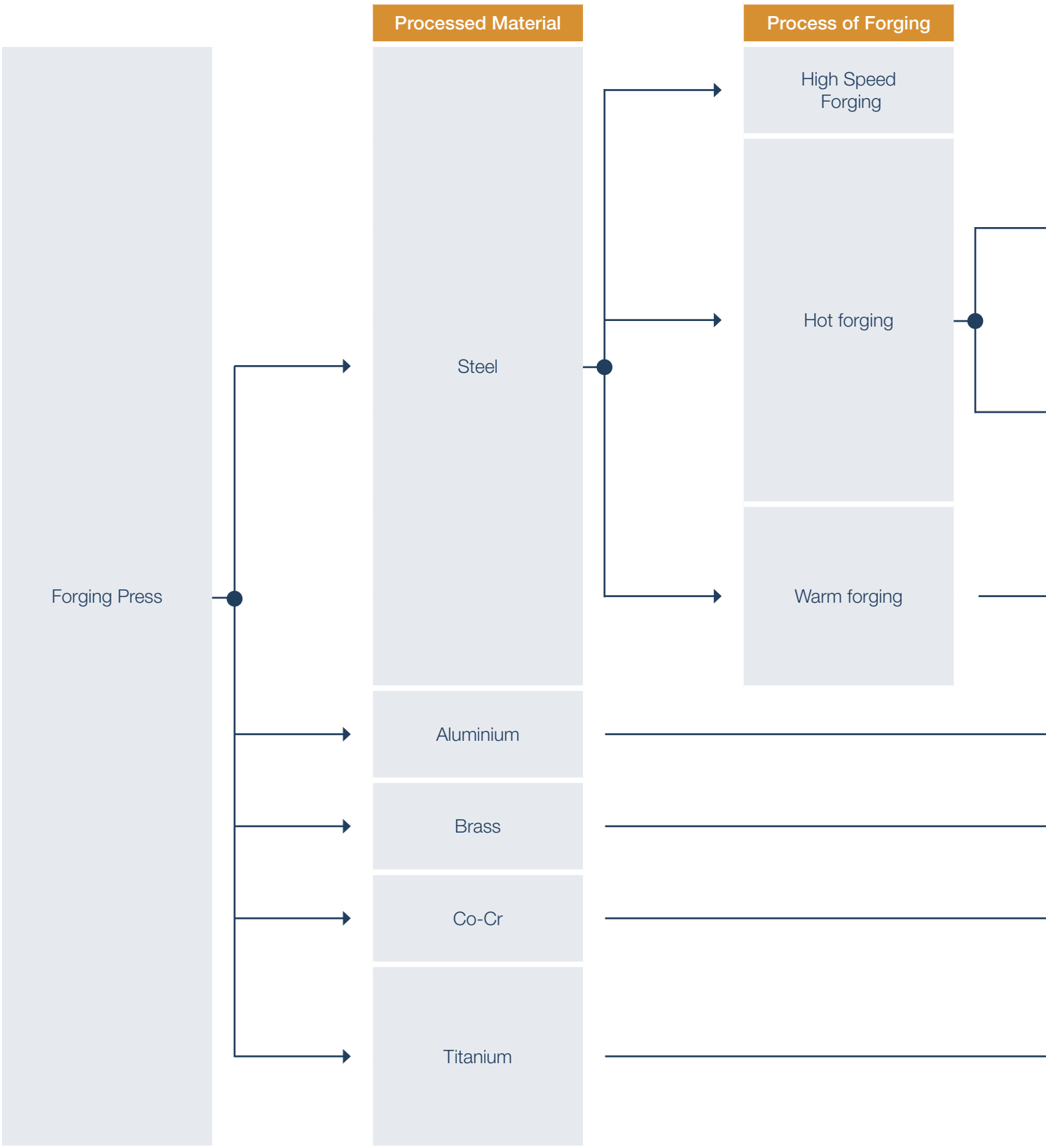
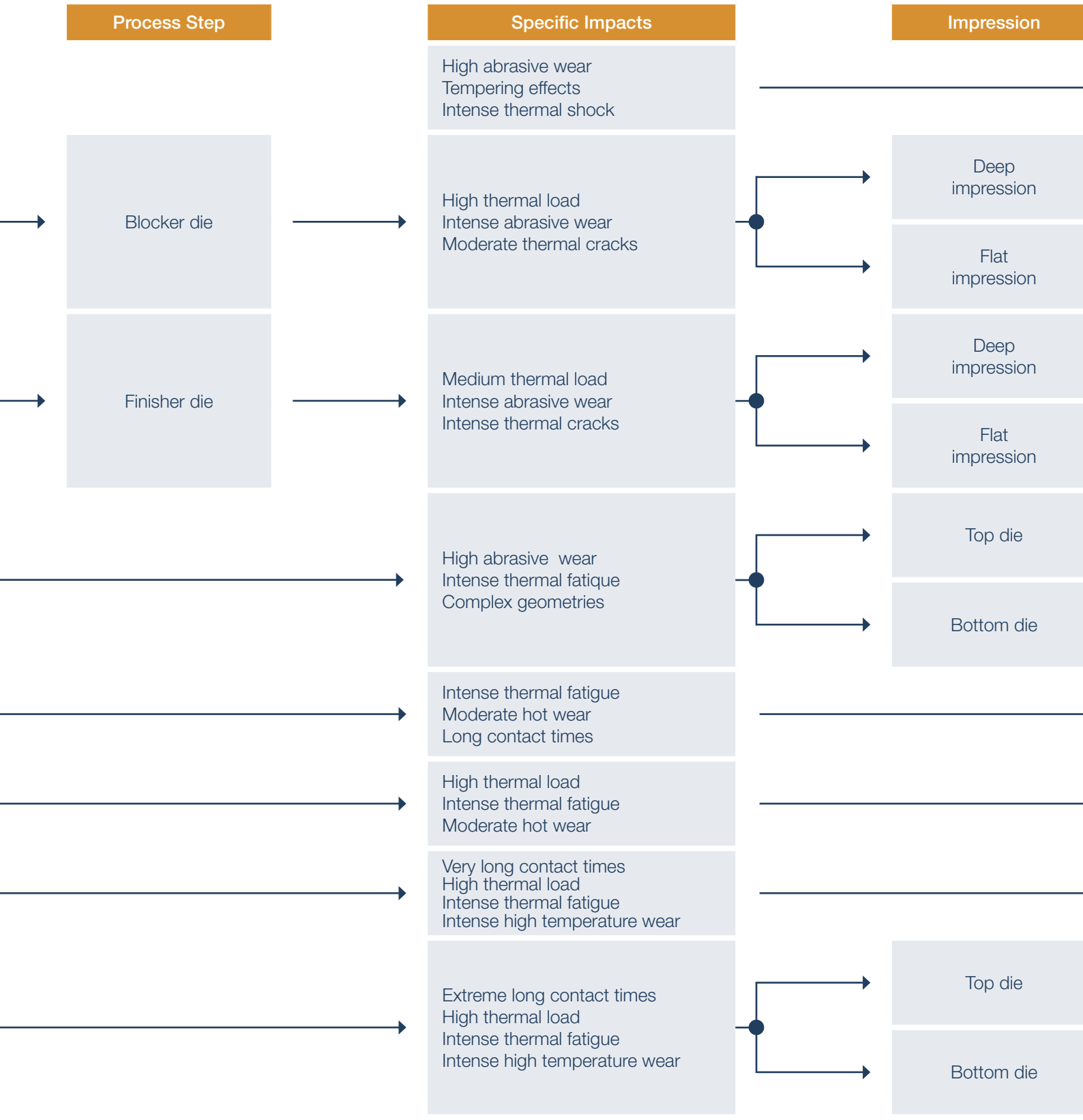
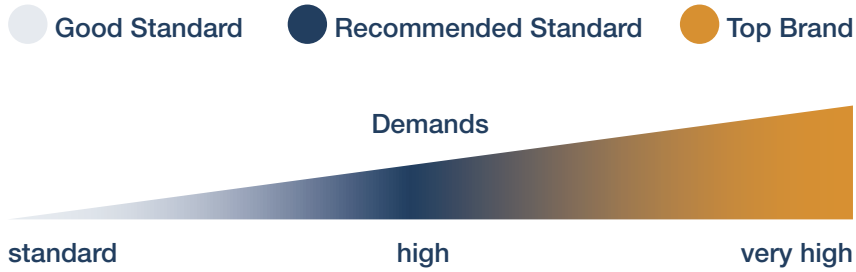
Tool steel selection for improved economics in closed-die forging with forging presses.




Process Step
Specific Impacts
Impression
High abrasive wear
Tempering effects
Intense thermal shock
Blocker die
High thermal load
Intense abrasive wear
Moderate thermal cracks
Deep impression
Flat impression
Finisher die
Medium thermal load
Intense abrasive wear
Intense thermal cracks
Deep impression
Flat impression
High abrasive wear
Intense thermal fatique
Complex geometries
Top die
Bottom die
Intense thermal fatigue
Moderate hot wear
Long contact times
High thermal load
Intense thermal fatigue
Moderate hot wear
Very long contact times
High thermal load
Intense thermal fatigue
Intense high temperature wear
Extreme long contact times
High thermal load
Intense thermal fatigue
Intense high temperature wear
Top die
Bottom die



Main Failure			
Wear	USD (50-54 HRC)	RPU 50-54 HRC	CS1 53-57 HRC
Wear	RPU 42-46 HRC	CR7V-L 42-46 HRC	CS1 44-48 HRC
Wear	RPU 46-50 HRC	CR7V-L 46-50 HRC	CS1 50-54 HRC
Radial cracks	RPU 40-44 HRC	CR7V-L 40-44 HRC	CS1 44-48 HRC
Radial cracks	RPU 44-48 HRC	CR7V-L 44-48 HRC	CS1 48-52 HRC
Wear	RPU 49-53 HRC	Q 10 49-53 HRC	FTCo 53-57 HRC
Radial cracks Wearout	RPU 48-52 HRC	Q 10 48-52 HRC	CS1 52-56 HRC
Radial cracks	USN ESR 42-46 HRC	HP1 44-48 HRC	CS1 44-48 HRC
Thermal fatique cracks	RPU 48-52 HRC	Q 10 50-54 HRC	FTCo 53-57 HRC
Thermal fatigue cracks, Wear	USN ESR 48-52 HRC	USN ESR 50-54 HRC	CS1 53-57 HRC
Wear	USD ESR 48-52 HRC	USN ESR 48-52 HRC	CR7V-L 50-54 HRC
Die cracking	USD ESR 48-52 HRC	HP1 48-52 HRC	CS1 50-54 HRC

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Experiences from the forging industry

Product	Machine Type	Grade in Comparison	Reason for Failure	Kind Special Tool Steel	Improved Lifetime Forged Against Standard Used before
Complex design of metal braket	Forging hammer	1.2714 – 38-40 HRC	deep cracks in the bottom radius	GSF – 40-42 HRC	2 times less cracks less remachining
Ring gear made of engineering steel	Hydraulic press 1600 tons	1.2367 – 45 HRC	failure due to die breakage	Q10 – 48-52 HRC	~ 3 times
Suspension parts	Hydraulic press 2500 tons Blocker and finisher	AISI H 11 (1.2343)	Wear	CR7V-L – 50-54 HRC	+ 50%
Larger connecting rods	Hydraulik press 3000 tons Finish forging die	Medium alloyed die steel, improved for toughness	Die crack	Q 10 – 44-46 HRC	+ 75%
Truck parts	Hydraulic press 6500 tons	1.2714	Crack	GSF – 38-42 HRC	+ 38%
Automotive suspension part	Hydraulic press 2500 tons Blocker and finisher	1.2343	Micro surface cracks and wear	CR7V-L – 50-54 HRC	+ 42%
Connecting rods	Hydraulic press 2500 tons	(1.2367)	Wear	CR7V-L – 50-52 HRC	+ 27%
Crankshafts	Hydraulic press 4000 tons Blocker die	AISI H 13 (1.2344)	Wear	CR7V-L – 40-42 HRC	+ 38%
Crankshafts	Hydraulic press 4000 tons Finisher die	AISI H 13 (1.2344)	Micro cracks	CR7V-L – 40-42 HRC	+ 26%
Crankshafts	Hydraulic press 12000 tons Blocker die	AISI H 13 (1.2344)	Wear	CR7V-L – 38-41 HRC	+ 43%
Connecting rods	Hydraulic press 2500 tons Blocker die	AISI H 13 (1.2344)	Wear	CR7V-L – 48-50 HRC 115000	+ 25%
Sector shafts	Mechanical press 2000 tons Hot forging 1st forging stage Bottom die	AISI H 13 (1.2344)	Wear	CR7V-L – 50-52 HRC	+ 35%
Sector shafts	Mechanical press 2000 tons Hot forging 2nd forging stage Bottom die	AISI H 13 (1.2344)	Cracking	Q10 – 48-50 HRC	+ 52%
Aluminium forging Chassis suspension parts components	Concatenated Forging line	many test series with different tool steel materials	Intensive radial cracks	HP1 – 45 HRC	Best performance of all tested standard and special grades
Orthopedic implant Ti and Co Cr alloys	Precision forging line Near net shape forging	1.2367 50-52 HRC	Radial cracks	CS1 – 53-55 HRC	+ 62%
Turbine blades made of Ti composite	Screw press 4000 tons and 8000 tons	(H 11) 1.2343 46-48 HRC	Cracks in the bottom die	USN ESR 3 d forged	+ 142%
Brass components	650 tons press	1.2367	Wear	130000 FTCo – 52 HRC	~ 5 times
Stem tool for high speed forging	Hatebur P 50	1.2365 50-52 HRC	Wear and intense deformation	FTCo – 54-56 HRC	~ 3 times
Spindels	Warm forging press 1st forging stage Bottom die	Warm forging press 1st forging stage Bottom die	Wear	CR7V-L – 52-54 HRC	+ 57%

Processes

Melting

Forging

Heat treatment

Machining

Surface treatment

Products

Hot work tool steels

Cold work tool steels

Die steels

Plastic mould steels

Industries

Die casting

Die forging

Extrusion

Tube manufacturing

Plastics technology

Hot stamping

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