KIND&CO
EDELSTAHLWERK

Premium
hot work tool steel
CS1

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CS1 application areas

Many users of hot work tool steels have a need for a higher working hardness of the tool materials.
The purposes of a higher hardness are:

- **increase in yield strength and hot yield strength**
- **increase in compression strength**
- **increase in wear resistance**

Increased hardness, heat resistance, and temper resistance contribute to an improved service life of tools. At the same time, however, lower toughness needs to be taken into account.

With the development of the CS1 (Clean / Strength) material, we confront this conflict. The combination of a customized composition, the most modern manufacturing processes, and optimal heat treatment leads to a high level of hardness and high toughness simultaneously.

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Nb
Spezial	CS1	0.50	0.30	0.40	5.00	1.90	0.55	+

The CS1 material is a chromium-molybdenumvanadium hot work tool steel that was specifically designed for tools with high mechanical demands. CS1 is a further development of the TQ1 hot work steel, which distinguishes itself by its high levels of both hardness and toughness. With its optimized alloying concept, the CS1 hot work tool steel offers excellent heat resistance, outstanding wear resistance, and optimal temper resistance. The CS1 hot work tool steel is in the “Super Clean” quality group. This lends the CS1 hot-work steel additional toughness and the best conditions for polishing work. The CS1 hot work tool steel exhibits good dimensional stability in heat treatment and use.

Extrusion

An actual trend in extrusion presses is the ever increasing extrusion ratio of extrusion billets to profile cross section. There is a growing demand for slender extrusion profiles, some of which are composed of heavy metals that are difficult to press. This trend leads to a significant increase in the extrusion pressures in the extrusion press and thus to an increase in the loads for the tools.
For years, Kind&Co. has developed premium steels and in doing so has offered solutions to problems in extrusion tool technology.
Along with familiar premium steels, such as TQ1, Q10, HP1, or HTR, Kind & Co. has developed an additional premium alloy. The CS1 material is distinguished by an even higher heat resistance while maintaining good toughness. Heavily loaded tools such as dies, extrusion discs, extrusion punches, or inner bushings achieve greater longevity compared to tools made of materials which have been used before.

- highly stressed dies, extrusion discs, and inner bushings
- products that require a high level of hardness and toughness

Plastics molding

The high level of hardness and toughness resulting from, among other things, the electro-slag re-melting process, offer the ideal prerequisite for high-gloss polished surfaces. This increased hardness significantly improves the polishability. Yet a high level of toughness remains, which is necessary for complex mold geometries. The high level of hardness ensures great abrasive resistance and enables improved tool performance in the processing of fiber-reinforced plastics. In addition, high homogeneity and a very fine micro-structure make the CS1 material optimally suitable for graining.

- highly polished mold inserts and mold plates in injection molding
- geometries in molds and machine components that are subject to high pressure and tension
- texturized mold inserts and mold plates for processing fiber-glass reinforced plastics with a high fiber-glass content

Hot stamping

In a direct hot stamping process, sheets heated to approx. 930°C are inserted into the stamping tool, then molded while they are warm, and then chilled in the mold. During this process, high-temperature wear and cracks can occur on the individual tool segments.
In this increasingly important production process, hightemperature wear resitance, toughness, and heat resistance are demanded from the tool steels used. The CS1 hot work tool steel fulfills these requirements and thus offers the ideal prerequisites for a greater tool service life.

- shaping tool segments
- thin walls
- cooling channels near to the surface

Die forging

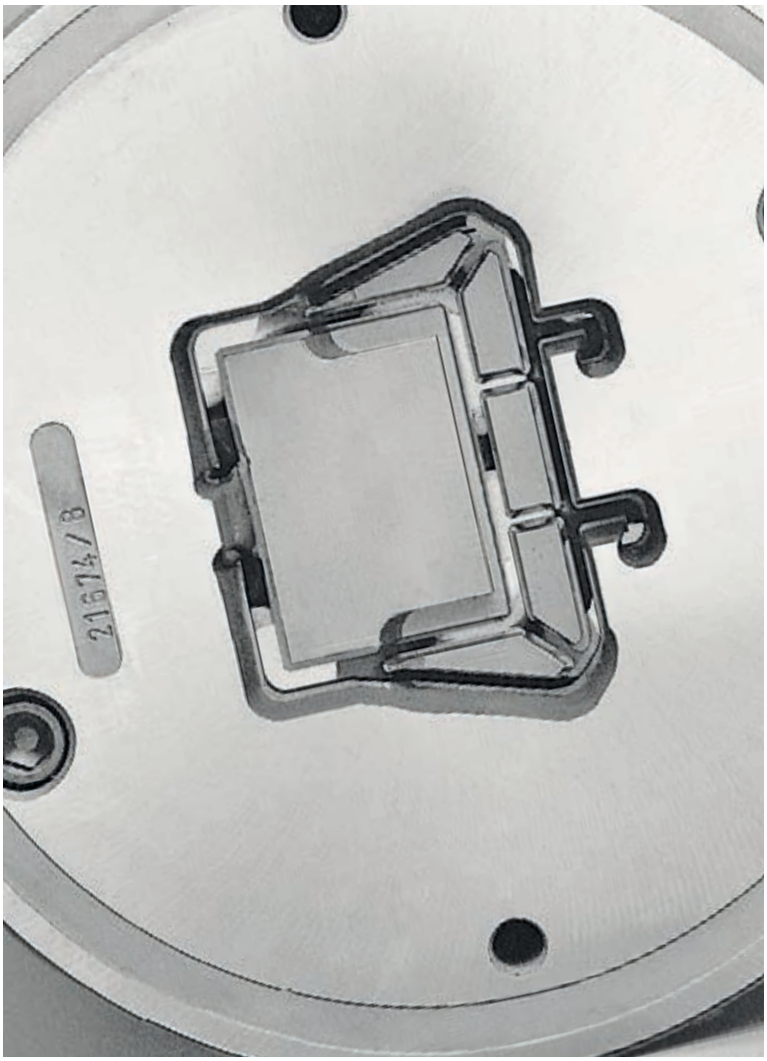
The most common cause of die failure is wear. This occurs, for example, in the form of erosion, desquamation, or material deposits.
Using the CS1 premium steel can extend the dies' maintenance interval. The special composition of the CS1 material increases temper resistance, heat resistance, and wear resistance. CS1 enables an increase in the service life of the forging dies, for which abrasive wear is a main issue.

- Dies with flat engravings and a high level of surface hardness
- Die engravings with high abrasive demands

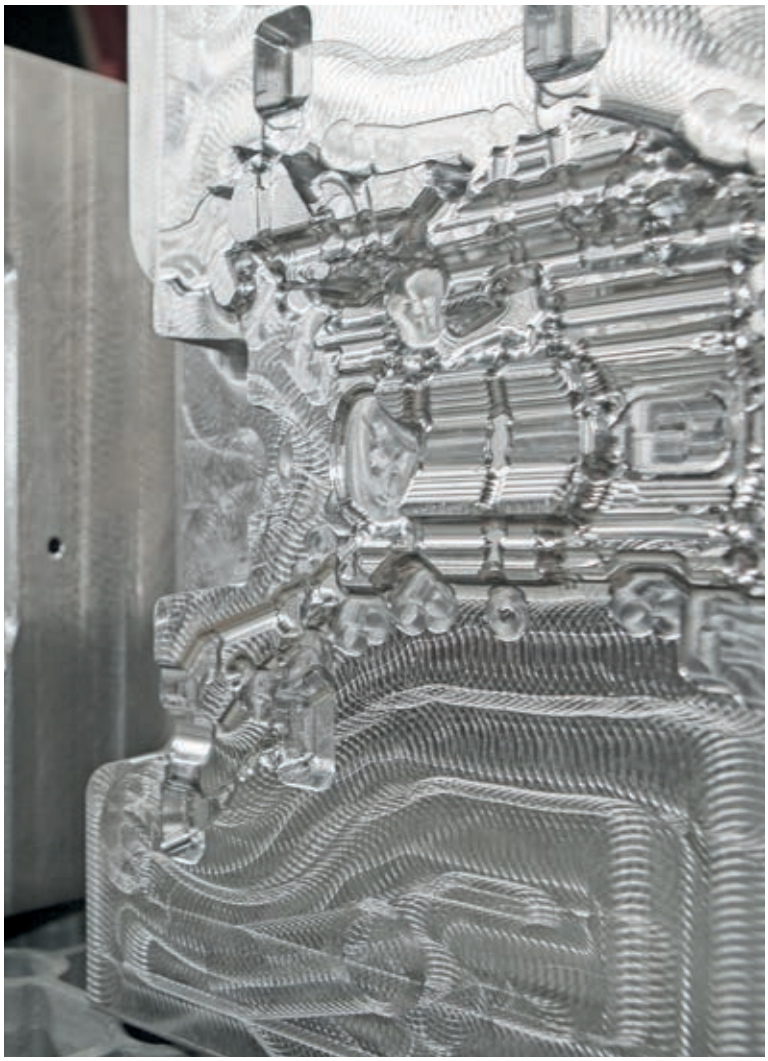
Die casting

Aluminum or magnesium pressure die casting places high demands on the tool steels used in the die casting mold. It is especially high filling pressures and flow speeds that lead to a high amount of local stress. The wear that comes with it can be counteracted by the use of CS1. With a significantly greater working hardness, as can be achieved with CS1, the hot yield strength and thermal shock resistance improve considerably. In addition, the high long-term heat resistance markedly reduces a loss in hardness in the affected areas.

- Pressure die casting molds
- Dividers in the gating sections

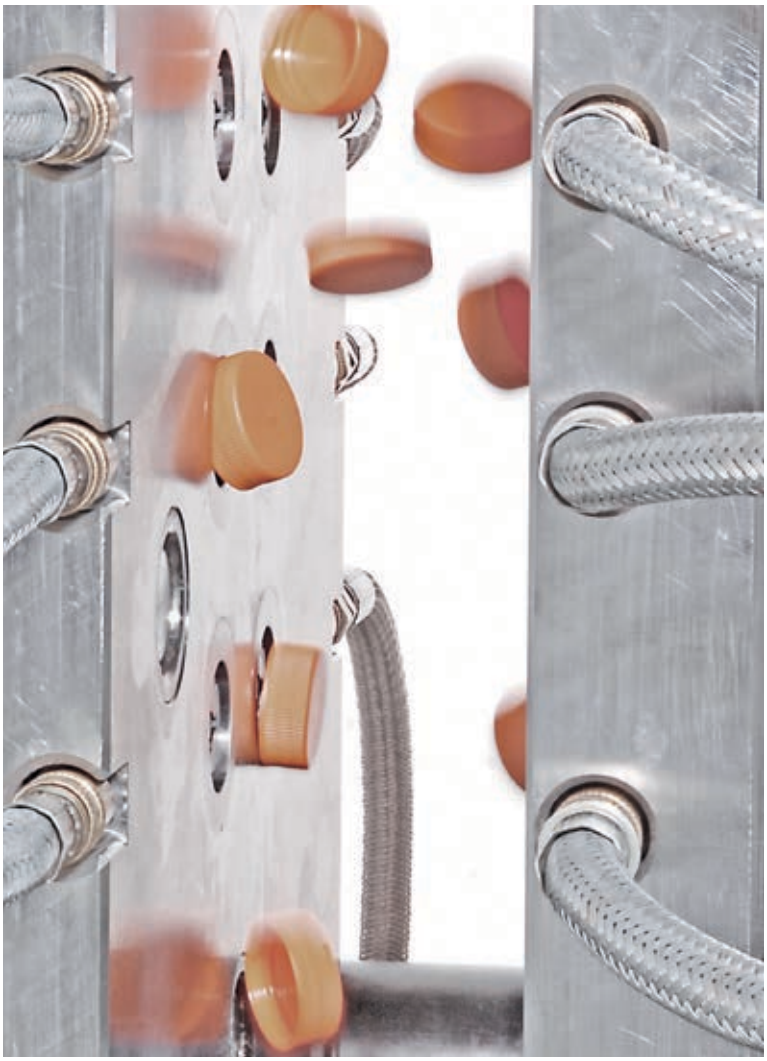


Extrusion ▲



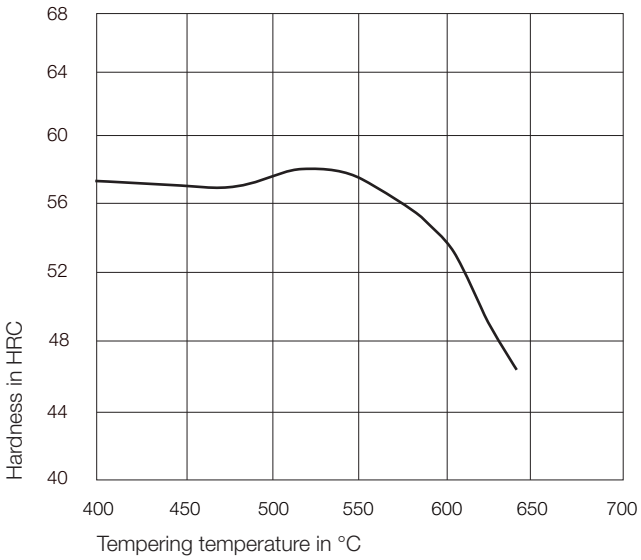
Die casting ▲

Plastics molds ▼



Die forging ▼

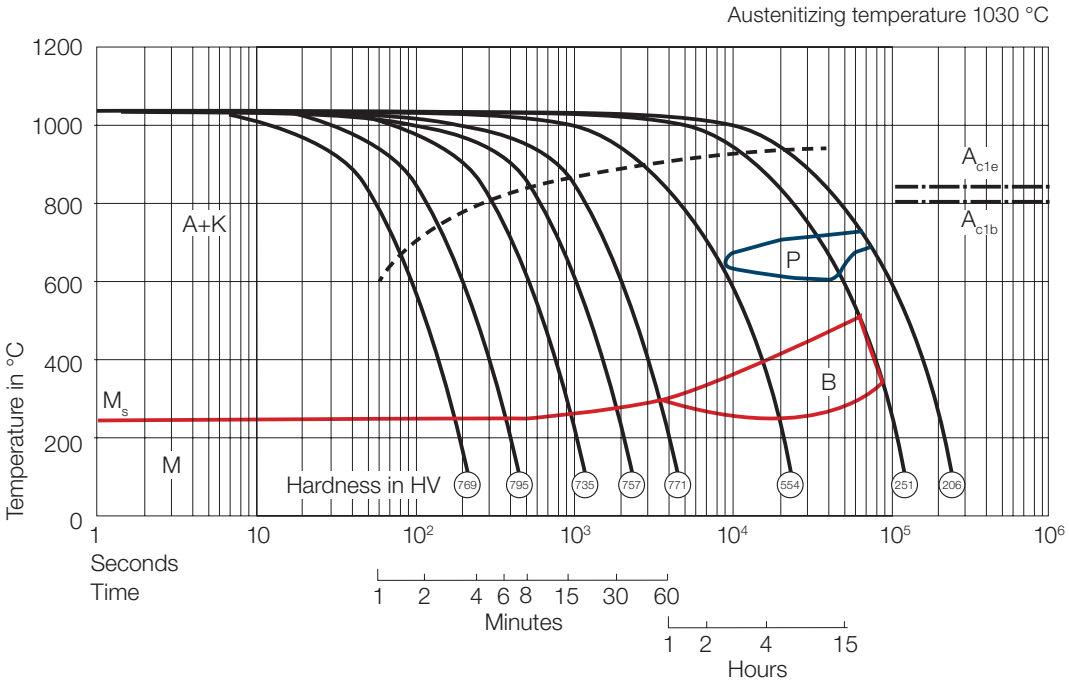
Tempering diagram



Tensile strength at room temperature

	45 HRC	54 HRC	58 HRC
$R_{p0,2}$ in MPa	1170	1500	1760
R_m in MPa	1465	1880	2202
A_5 in %	11	8	8
Z in %	36	30	26

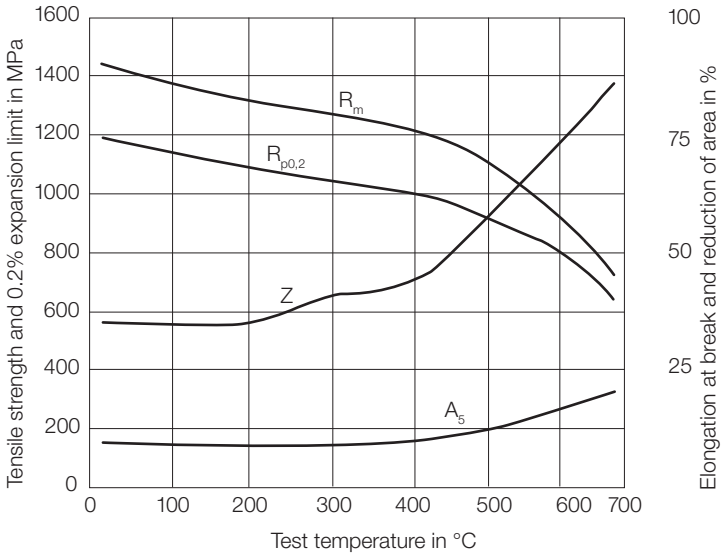
Time-temperature transformation diagram / austenitization 1030°C, 30 min



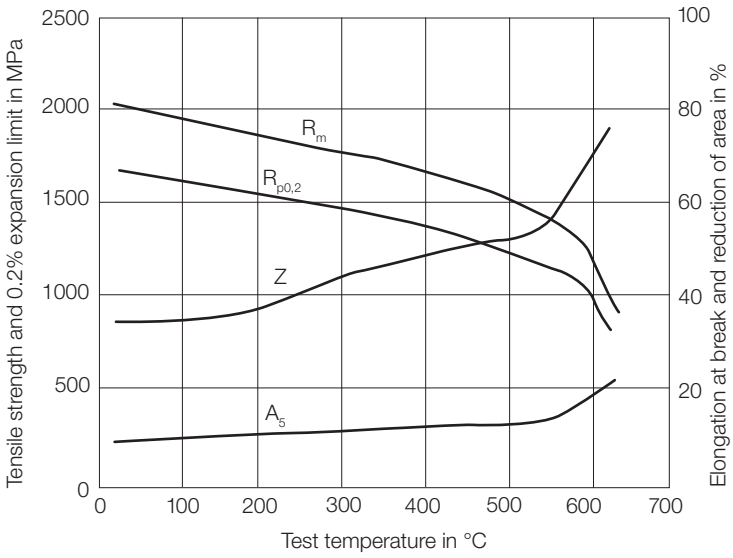
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,8	12,5	13,2	13,4
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	28,8	30,0	29,4	
Temperature in °C	20			
Density in g/cm³	7,79			
Temperature in °C	20			
E module in GPa	213			

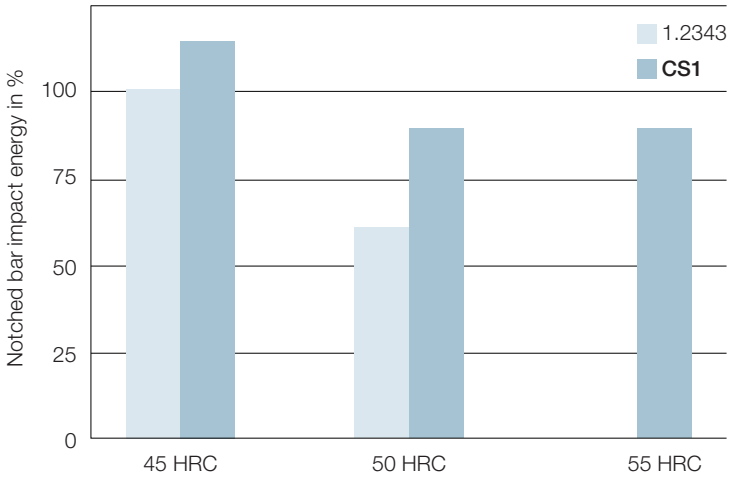
High-temperature strength diagram 45 HRC



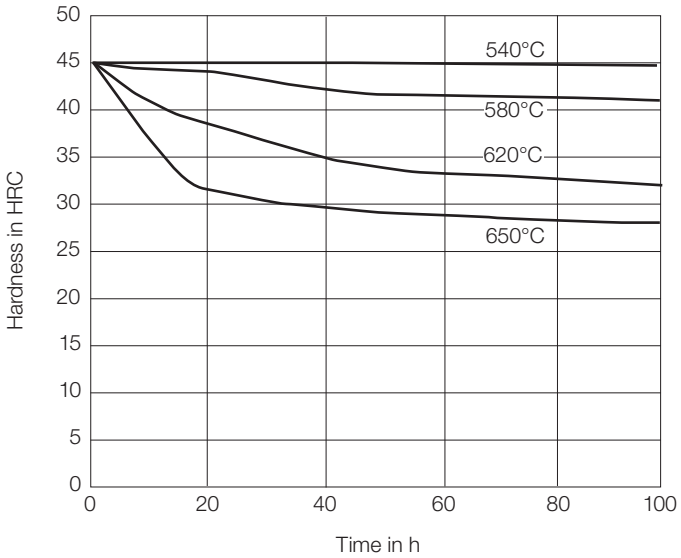
High-temperature stength diagram 56 HRC



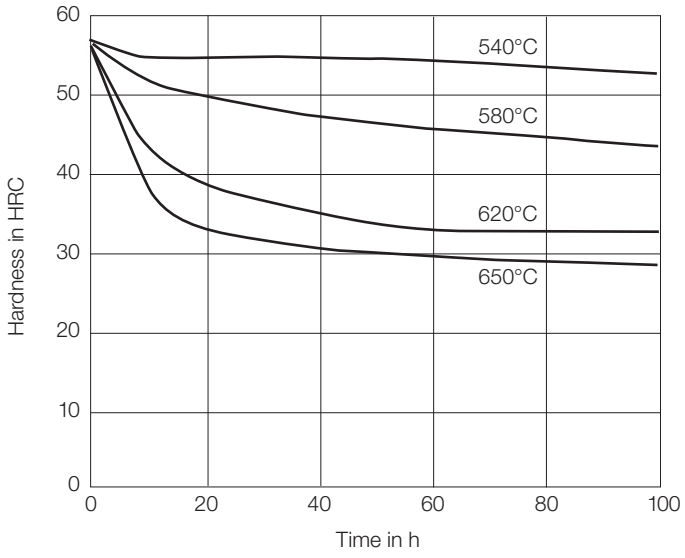
Toughness comparison



Long-term temper resistance 45 HRC



Long-term temper resistance 56 HRC



Service

Tool steels

Melting

Forging

Heat treatment

Machining

Surface treatment

Products

Hot work steels

Cold work steels

Die steels

Plastic mould steels

Industries

Die casting

Die forging

Extrusion

Tube manufacturing

Plastics technology

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