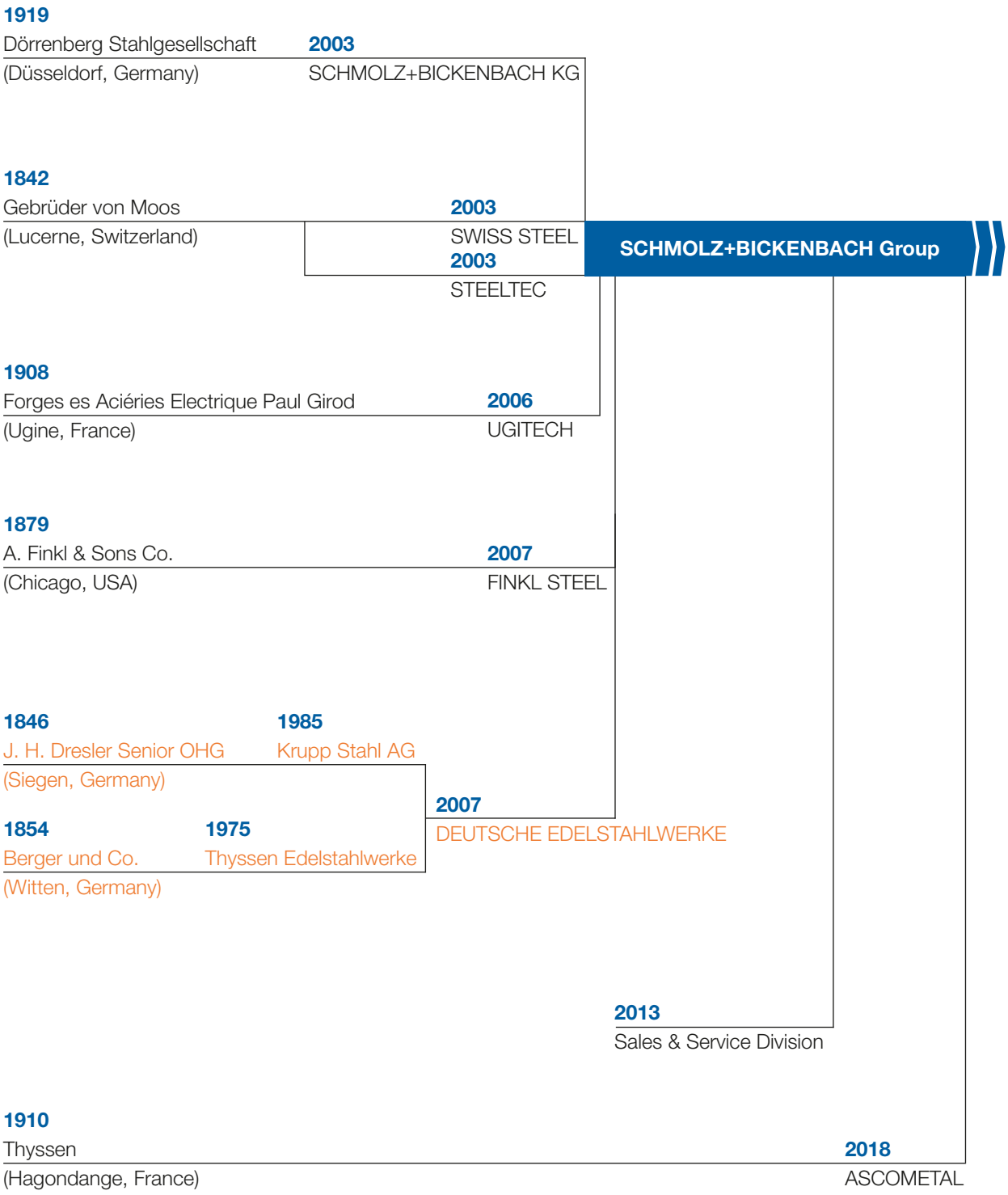
High Pressure Die Casting

Special steels for increasing customer demands

SCHMOLZ + BICKENBACH GROUP

DEUTSCHE EDELSTAHLWERKE

SCHMOLZ+BICKENBACH Group



Deutsche Edelstahlwerke - your partner for high quality tool steel solutions

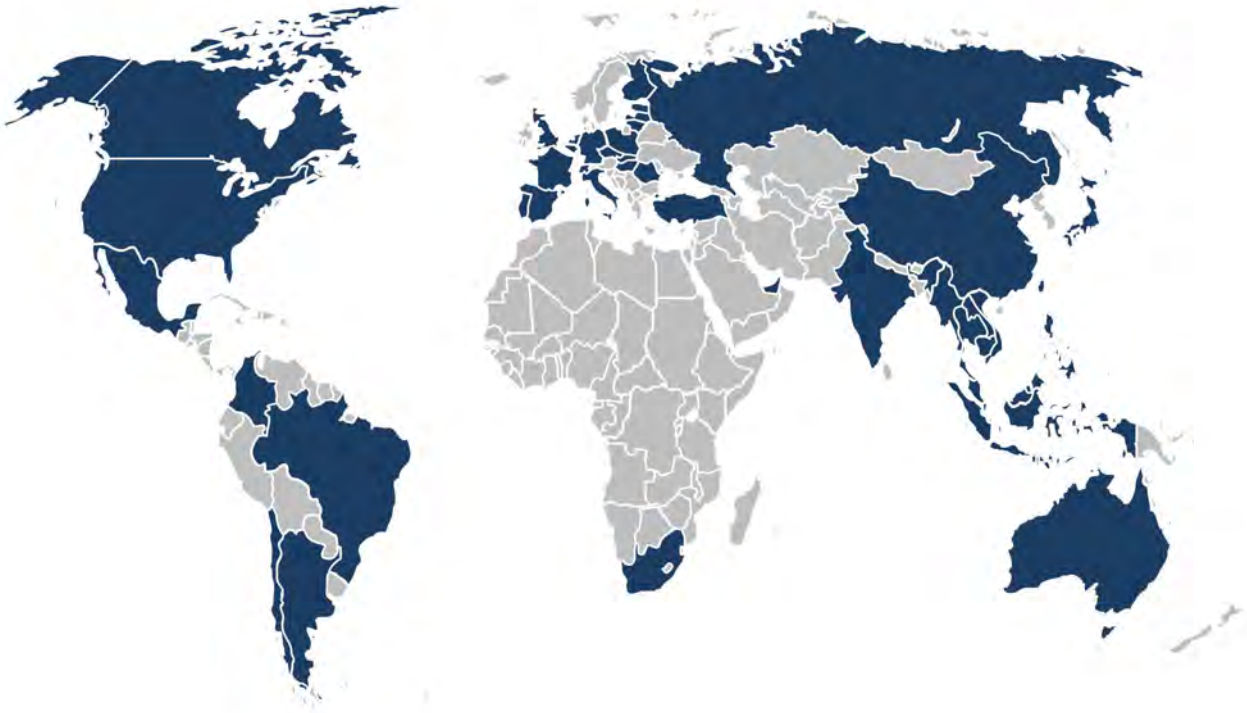
Deutsche Edelstahlwerke is one of the world's leading manufacturers of special steel long products. Deutsche Edelstahlwerke can look back on over 170 years of experience in the production of high-grade steel products.

The range of products is unique worldwide and includes tool steels, stainless, acid and heat-resistant steels, engineering and bearing steels, and special materials. The product portfolio ranges from 4.5 mm drawn wire to forged products of up to 1,100 mm in diameter.

Deutsche Edelstahlwerke customers receive the entire manufacturing chain from a single source: from production to prefabrication to heat and surface treatment.
Deutsche Edelstahlwerke is a company of the SCHMOLZ+BICKENBACH Group.

The SCHMOLZ+BICKENBACH Group is one of the world's leading providers of individual solutions in the special long steel products sector. The Group is one of the leading manufacturers of tool steel and non-corrosive long steel on the global market and one of the two largest companies in Europe for alloyed and high-alloyed quality and engineering steels.

With more than 10 000 employees and its own production and distribution companies in more than 30 countries on 5 continents, the company guarantees global support and supply for its customers and offers them a complete portfolio of production and sales & services around the world. Customers benefit from the company's technological expertise, consistently high product quality around the world as well as detailed knowledge of local markets.



High Pressure Die Casting

High pressure die casting is one of the most cost-effective manufacturing processes used in the foundry industry and is renowned for its high dimensional accuracy and homogeneity during series production. This method entails injecting molten metal into a die cavity at a very high speed.

The pressure applied to transport the molten foundry metal stream into even the narrowest of cross section is imperative for precise shape reproduction, which is one of the special benefits of high pressure die casting.

Pressure die cast parts are predominantly designed to be as thin-walled as possible in order to allow shorter cycle times and to reduce casting material. Nevertheless, the moulds are exposed to considerable mechanical and thermal loads during die casting, which is why the durability of a die is of particular importance.

The die‘s service life depends largely on the quality of the hot work tool steel as well as its means of production and heat treatment.

The effects that choosing suitable steels and the purposeful adjustment of individual alloys can have on the die’s quality, reliability, and service life, should therefore not be underestimated.

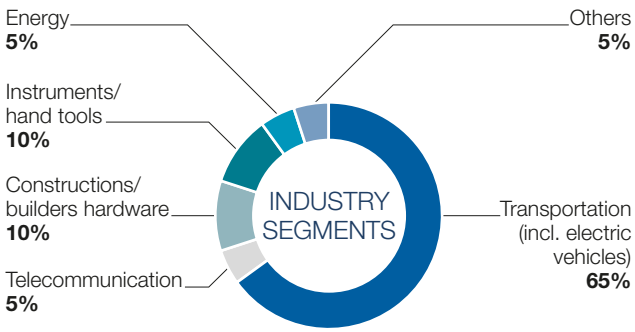
During the die casting process, temperatures fluctuate immensely and the fluctuation intervals are extremely short and vary from metal to metal. This makes the thermal shock resistance of the hot work tool steel a top priority for the die caster.

The steel should offer the following properties:

- **Excellent thermal shock resistance**
- **Great high temperature strength**
- **Outstanding toughness at elevated temperatures**
- **High thermal conductivity**
- **Excellent wear resistance at elevated temperatures**
- **High compression strength**
- **Good weldability**

Die casting parts are used in numerous applications as displayed in below diagram. By far the most important application area is the automotive industry, wherein the parts are used in cars, trucks or two-wheelers.

The changing powertrain technology will significantly influence the market, while also offering new opportunities in the area of electric vehicles.



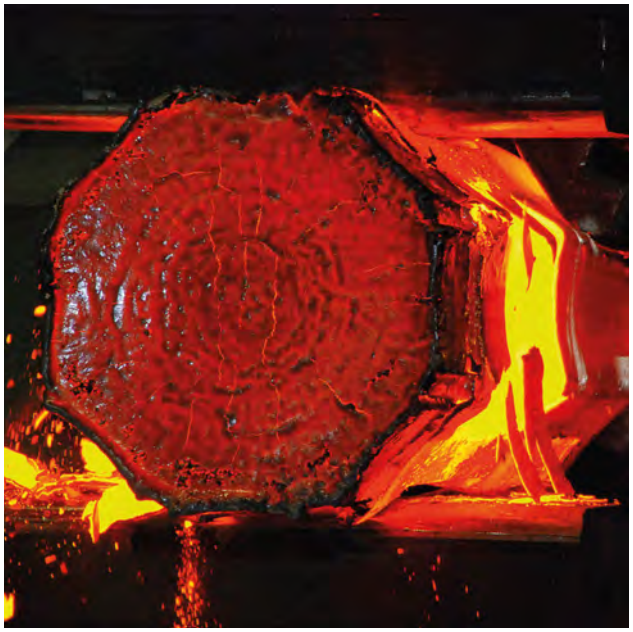
At Deutsche Edelstahlwerke you will always receive high performance steels, which set global standards for hot work tool steels.

Benefits for the tool manufacturer

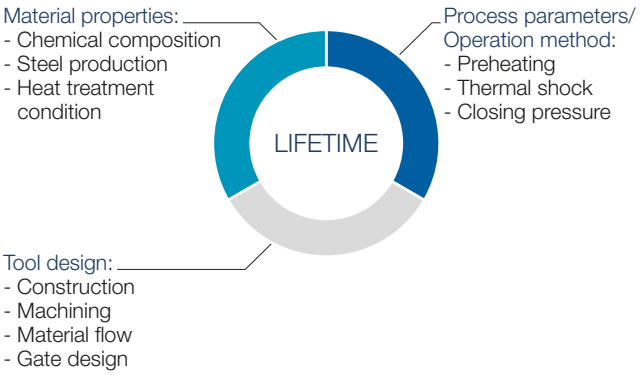
- Consistent quality
- Cost-effective machinability
- Uncomplicated heat treatment
- Good repair weldability
- Competent consulting
- Short delivery times

Benefits for the die caster

- Long service life
- Low die costs and low costs per unit
- Low susceptibility to hot cracking
- Negligible repair efforts
- Good repair weldability
- Low tool turnover
- Technical consulting
- Good dimensional stability
- Reproducible die casting quality



The main criteria of a die is the lifetime as strong key figure for the efficiency of the process. Beside of the die material there are various aspects influencing the lifetime.



In the die casting industry new and challenging trends are recognisable that lead to new limitations but also new possibilities:

- Higher efficiency
- Increasal of the number of shots (standardization/platform strategy)
- Big diversity of casting alloys (aluminum, magnesium, zinc, etc.)
- Weight reduction of the produced parts to achieve less CO_2 emissions
- Higher complexity of the produced parts
- Additive manufactured 3D-printed tools
- Dies with bigger dimensions for structural parts
- Coating of the surface to avoid abrasion and to achieve better sliding and ejecting properties

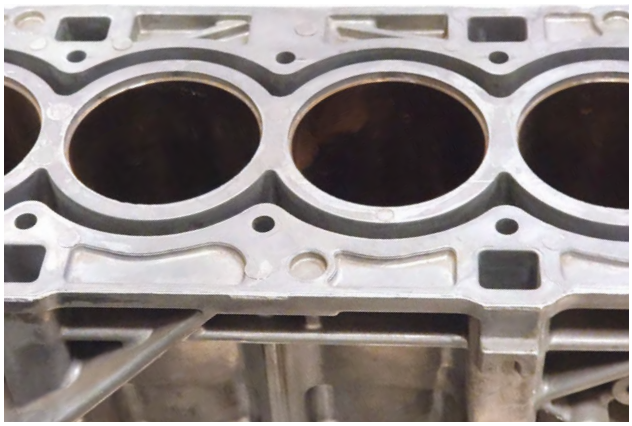
Steel selection for highest demands

For the increasing demands in the high pressure die casting industry we recommend using our high performance hot work tool steels from our Thermodur® Superclean range for more durable, reliable and cost-effective dies. These Electro-Slag Remelted (ESR) grades offer the required property profile with highest toughness values combined with a homogeneous microstructure and the finest grain size. Additionally we also offer the standard materials in our special condition with Extra Fine Structure (EFS) as Thermodur® 2343 EFS, Thermodur® 2344 EFS and Thermodur® 2367 EFS in non ESR condition.

Thermodur® 2343 EFS Superclean is an electro slag remelted hot work tool steel, which can be applied universally. It offers a high toughness potential and is thus particularly successful with large dies for the processing of light metal alloys. The most notable properties of Thermodur® 2343 EFS Superclean are its high-temperature strength and toughness as well as the proper thermal conductivity and insusceptibility to hot cracking.

Thermodur® 2344 EFS Superclean is a versatile hot work tool steel, which can be used in a wide range of applications. Compared to Thermodur® 2343 EFS Superclean, it features increased tempering and wear resistance. This makes it especially suitable for small- to medium-sized dies in the production of light metal die castings.

Thermodur® 2367 EFS Superclean combines the positive properties of Thermodur® 2343 EFS Superclean and 2344 EFS Superclean, while also offering improved high temperature strength and temperature stability.
Its excellent tempering and heat checking resistance make Thermodur® 2367 EFS Superclean perfect for the production of light metal die castings frequently subjected to high temperatures.



Thermodur® 2999 EFS Superclean is a special hot work tool steel with maximum high temperature strength, excellent thermal shock resistance and high thermal conductivity. Due to its strong high temperature wear resistance Thermodur® 2999 EFS Superclean was especially developed for use at highest temperatures. This property profile makes Thermodur® 2999 EFS Superclean to a special solution for inserts in light and heavy metal die casting.

Thermodur® E 38 K Superclean is an electro slag remelted hot work tool steel, which can be applied universally. The outstanding toughness values in comparison with Thermodur® 2343 EFS Superclean make Thermodur® E 38 K Superclean the best solution for large high pressure die casting dies.

Thermodur® E 40 K Superclean is the premium hot work tool steel for HPDC dies and improves the lifetime due to an outstanding heat checking resistance. It combines highest toughness values with improved high temperature strength and is thus the perfect solution for die casting dies. With its high wear resistance at elevated temperatures and good isotropy of mechanical values Thermodur® E 40 K Superclean is the best solution for medium- to large-dimensioned dies.

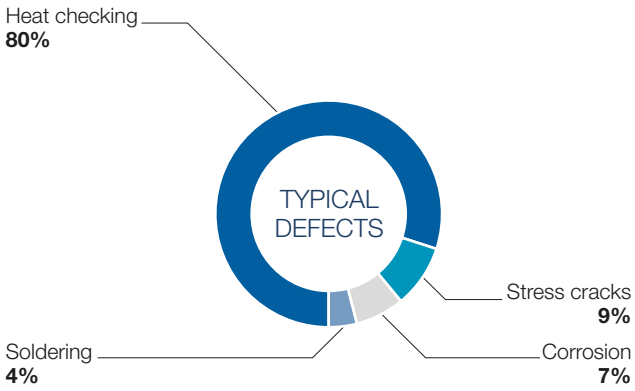
Provided by VETIMEC Soc Coop.

Brand	NADCA #207-2018*	
	Grade	Type
Thermodur® 2343	D	D 1830
Thermodur® 2344	A and B	A 1885 and B 1885
Thermodur® 2367	C	C 1885
Thermodur® E 38 K	E	E 1850
Thermodur® E 40 K Superclean	H	H 1885

* Special Quality Die Steel & Heat Treatment
Acceptance Criteria for Die Casting Dies, NADCA #207-2018

Failure causes in die casting applications

In the die casting industry the demand for higher lifetime expectancy is unbroken.
For that reason DEW is focused on the major defect types of die casting dies to identify space for improvement.
As roughly 80 % of all failures were caused by heat checking, the improvement of the resistance against this defect type is the biggest challenge.



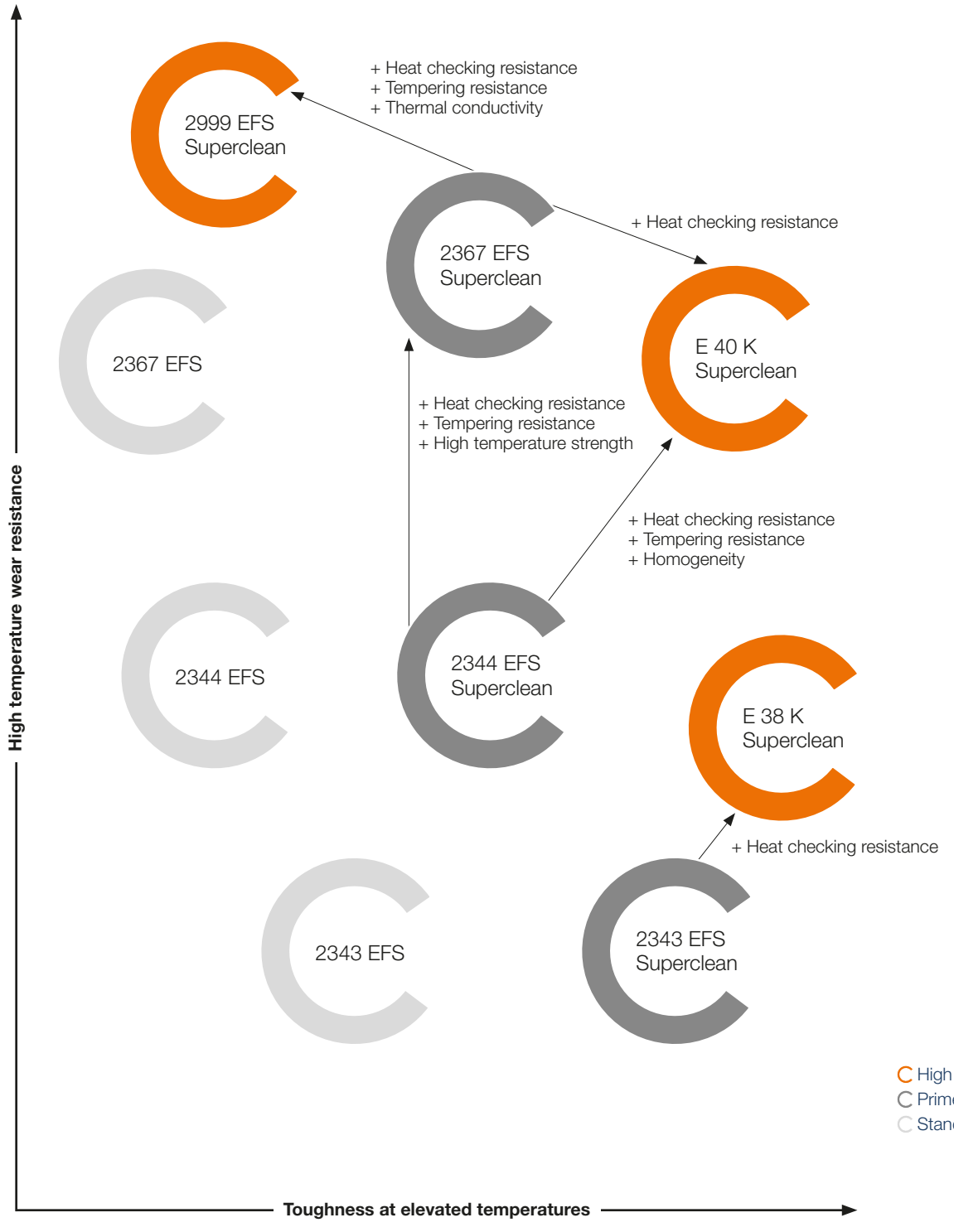
Steel choice

Depending on the application, shape, casting alloy, dimension of the tool and further factors the steel choice should be done by consideration of the entire property profile the specific steel grades offer.
In below table a comparison about the main properties of our hot work tool steels used in die casting applications is given.

We subdivide our hot work tool steels into Standard material in conventional condition, Prime Quality in ESR condition and High Performance materials which are specially developed to reach outstanding results even in highly stressed HPDC tools.

Brand	Thermal shock resistance	Toughness	Tempering resistance	Wear resistance	Thermal conductivity	Polishability
Thermodur® 2343 EFS	•	••	••	••	••	••
Thermodur® 2343 EFS Superclean	••	••••	••	••	••	••
Thermodur® 2344 EFS	•	•	••	•••	••	••
Thermodur® 2344 EFS Superclean	••	•••	••	•••	••	•••
Thermodur® 2367 EFS	•••	•	•••	••••	•••	••
Thermodur® 2367 EFS Superclean	••••	•••	•••	••••	•••	•••
Thermodur® 2999 EFS Superclean	•••••	•	••••	•••••	••••	••
Thermodur® E 38 K Superclean	••••	•••••	••	••	••	•••••
Thermodur® E 40 K Superclean	•••••	••••	•••	••••	•••	••••

Decision tree



Machining values for drilling tool steels

Grade	Treatment condition	Cutting speed v = m/min			Feed rate s = mm/rev.			Drill diameter mm		
		3343/ 3243	3343/ 3243 +TIN	HM K 10	3343/ 3243	3343/ 3243 +TIN	HM K 10	3343/ 3243	3343/ 3243 +TIN	HM K 10
Thermodur® 2343 EFS	Annealed	8-14	18-23	40-60	0.04-0.14	0.12-0.20	0.06-0.20	8-16	8-16	20-47
Thermodur® 2344 EFS	Annealed	8-14	18-23	40-60	0.04-0.14	0.12-0.20	0.06-0.20	8-16	8-16	20-47
Thermodur® 2367 EFS	Annealed	8-14	18-23	40-60	0.04-0.14	0.12-0.20	0.06-0.20	8-16	8-16	20-47
Thermodur® 2999 EFS	Annealed	8-14	18-23	40-60	0.04-0.14	0.12-0.20	0.06-0.20	8-16	8-16	20-47
Thermodur® E 38 K Superclean	Annealed	8-14	18-23	40-60	0.04-0.14	0.12-0.20	0.06-0.20	8-16	8-16	20-47
Thermodur® E 40 K Superclean	Annealed	8-14	18-23	40-60	0.04-0.14	0.12-0.20	0.06-0.20	8-16	8-16	20-47

Machining values for turning tools using HSS and carbide cutting tools

Grade	Treatment condition	HSS tool RAPIDUR® 3207		RAPIDUR® 3207		Carbide cutting tool Coated with P25/P25 TIALAN		P10/P15	
		Rough-machining		Finish-machining		Rough-machining		Finish-machining	
		Cutting speed Vc (m/min)	Feed rate s = mm/U	Cutting speed Vc (m/min)	Feed rate s = mm/U	Cutting speed Vc (m/min)	Feed rate s = mm/U	Cutting speed Vc (m/min)	Feed rate s = mm/U
Thermodur® 2343 EFS	Annealed	15-25	0.2-0.4	25-50	0.1-0.2	125-195	0.4-1.0	250-370	0.1-0.4
Thermodur® 2344 EFS	Annealed	15-25	0.2-0.4	25-50	0.1-0.2	125-195	0.4-1.0	250-370	0.1-0.4
Thermodur® 2367 EFS	Annealed	15-25	0.2-0.4	25-50	0.1-0.2	125-195	0.4-1.0	250-370	0.1-0.4
Thermodur® 2999 EFS	Annealed	10-20	0.2-0.4	20-30	0.1-0.2	115-175	0.4-1.0	235-350	0.1-0.4
Thermodur® E 38 K Superclean	Annealed	15-25	0.2-0.4	25-50	0.1-0.2	125-195	0.4-1.0	250-370	0.1-0.4
Thermodur® E 40 K Superclean	Annealed	15-25	0.2-0.4	25-50	0.1-0.2	125-195	0.4-1.0	250-370	0.1-0.4

Machining values for milling tools using HSS and carbide cutting tools

Grade	Treatment condition	HSS tool RAPIDUR® 3207		RAPIDUR® 3207		Carbide cutting tool Coated with P40 TIALAN		P25	
		Rough-machining		Finish-machining		Rough-machining		Finish-machining	
		Cutting speed Vc (m/min)	Feed rate s = mm/U	Cutting speed Vc (m/min)	Feed rate s = mm/U	Cutting speed Vc (m/min)	Feed rate s = mm/U	Cutting speed Vc (m/min)	Feed rate s = mm/U
Thermodur® 2343 EFS	Annealed	10-18	0.1-0.2	15-30	0.05-0.1	110-170	0.3-0.6	110-170	0.1-0.2
Thermodur® 2344 EFS	Annealed	10-18	0.1-0.2	15-30	0.05-0.1	110-170	0.3-0.6	110-170	0.1-0.2
Thermodur® 2367 EFS	Annealed	10-18	0.1-0.2	15-30	0.05-0.1	110-170	0.3-0.6	110-170	0.1-0.2
Thermodur® 2999 EFS	Annealed	8-10	0.18-0.25	10-15	0.2-0.4	80-160	0.2-0.4	90-180	0.15-0.25
Thermodur® E 38 K Superclean	Annealed	10-18	0.1-0.2	15-30	0.05-0.1	110-170	0.3-0.6	110-170	0.1-0.2
Thermodur® E 40 K Superclean	Annealed	10-18	0.1-0.2	15-30	0.05-0.1	110-170	0.3-0.6	110-170	0.1-0.2

Heat treatment

Stress-relief annealing

Machining stresses occur during metal cutting and non-cutting shaping. These stresses may result in deformation and possibly expensive reworking in the course of subsequent heat treatment. Stress-relief annealing should be performed at a temperature of 600 to 650 °C after initial machining, especially for tools with a complex geometry.

Hardening | Heating

As a result of low thermal conductivity and different tool cross sections, considerable thermal stresses occur in the event of rapid heating to hardening temperature. These stresses may cause the tools to deform or even crack. Certain pre-heating stages indicated in the time-temperature sequences in the material data sheets must be observed.

Austenitizing

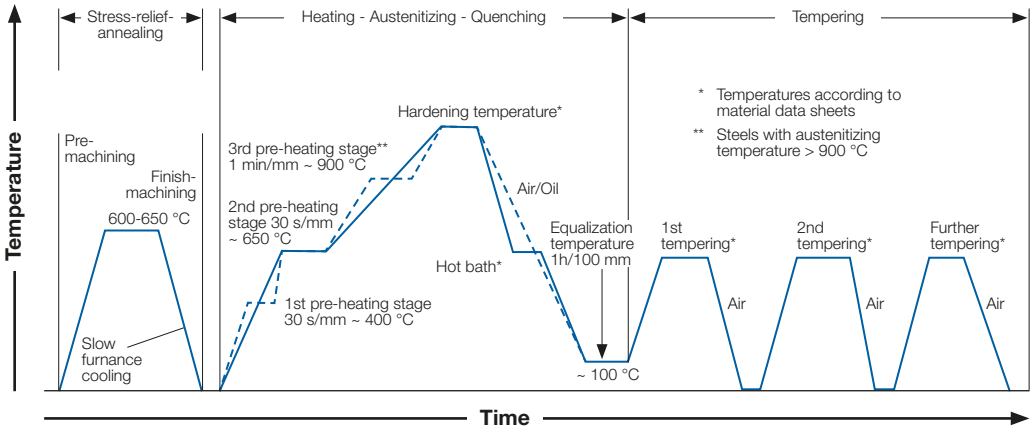
After the last pre-heating stage, the tools are brought up to hardening temperature listed in the material data sheets. After thorough heating (temperature equalization), they must be kept at this temperature to ensure complete transformation.

Quenching

Quenching the tools is the most critical phase of the heat treatment process. There is a risk of hardness tension cracks developing as a result of thermal and microstructural transformation stress. Design-related factors promoting cracking are abrupt material transitions, different wall thicknesses (webs), and large hardening cross sections. For the material, it would be ideal to aim for cooling to be as quick as possible in order to achieve a purely martensitic transformation. However, compromises are necessary due to the risk of cracking addressed earlier. Those compromises must be coordinated between the steel manufacturer, the heat treatment company and the toolmaker for each individual case.

Tempering

Tempering is necessary in order to achieve an appropriate hardness and toughness necessary for the intended service requirement. Tempering must be performed immediately after quenching and equalizing to prevent tension cracks.



Deutsche Edelstahlwerke
Specialty Steel GmbH & Co. KG
Auestraße 4
58452 Witten
GERMANY

Phone: +49 (0)2302 29 - 0
Fax: +49 (0)2302 29 - 4000

info@dew-stahl.com
www.dew-stahl.com

2020-002

SCHMOLZ + BICKENBACH Group
www.schmolz-bickenbach.com