Uddeholm
Vidar® Superior

UDDEHOLM
a voestalpine company

Uddeholm Vidar® Superior

Uddeholm Vidar Superior belongs to the new generation of modified H11 (1.2343) steel grades with a low silicon content. The steel is produced using the very latest in production techniques and shows very high toughness values.

Uddeholm Vidar Superior is tested and certified, providing the customer the best possible performance. Suitable applications are those where a high toughness is needed; like in die casting or forging. The high purity in Uddeholm Vidar Superior makes it an excellent steel also in plastic applications.

Classified according to EU Directive 1999/45/EC
For further information see our "Material Safety Data Sheets".

Edition 4, 09.2013

GENERAL

Uddeholm Vidar Superior is a chromium-molybdenum-vanadium alloyed hot work tool steel which is characterized by:

- High level of resistance to thermal shock and thermal fatigue
- Good high-temperature strength
- Excellent toughness and ductility in all directions
- Excellent through-hardening properties
- Good dimensional stability during hardening

Typical analysis %	C 0.36	Si 0.3	Mn 0.3	Cr 5.0	Mo 1.3	V 0.5
Standard specification	X36 CrMoV5 (CNOMO) X36 CrMoV5-1, W.-Nr. 1.2340 ~AISI H11, ~B H11, ~W.-Nr. 1.2343, ~AFNOR Z38 CDV 5, ~UNI X37 CrMoV 51 KU, ~UNE X37 CrMoV 5					
Delivery condition	Soft annealed to approx.180 HB					
Colour code	Red/orange with a white line across					

IMPROVED TOOLING PERFORMANCE

The name "Superior" implies that by special processing techniques and close process control, the steel attains high purity and a very fine structure. Uddeholm Vidar Superior shows significant improvements in impact toughness compared to material of the H11 (W.-Nr. 1.2343) type.

The improved impact toughness is particularly valuable for tooling subjected to high mechanical and thermal stresses, e.g. die casting dies and forging tools. In practical terms, tools may be used at somewhat higher working hardness (2 HRC) without loss of toughness. Since increased service hardness limits the formation of thermal fatigue cracks, improved tool performance can be expected.

APPLICATIONS

TOOLS FOR DIE CASTING

Part	Tin, lead, zinc alloys, HRC	Aluminium-, Magnesium alloys, HRC
Dies	46–50	42–48
Fixed inserts, cores	48–52	46–50
Sprue parts	(ORVAR)	(ORVAR)
Nozzles	(ORVAR)	(ORVAR)
Ejector pins (nitrided)	(ORVAR)	(ORVAR)
Plunger, shot-sleeve (normally nitrided)	(ORVAR)	(ORVAR)
Austenitizing temperature	980–1000°C (1795–1830°F)	

TOOLS FOR HOT FORGING

Material	Austenitizing temperature (approx.)	HRC
Aluminium, magnesium	980–1000°C (1795–1830°F)	44–52
Copper alloys	980–1000°C (1795–1830°F)	44–52
Steel	980–1000°C (1795–1830°F)	40–50

MOULDS FOR PLASTICS

Part	Austenitizing temperature (approx.)	HRC
Injection moulds Compression/ transfer moulds	980–1000°C (1795–1830°F)	46–52

PROPERTIES

PHYSICAL DATA

All specimens are taken from the centre of a 1000 x 200 mm (39,4" x 7,88") bar. Unless otherwise is indicated all specimens were hardened from 1000°C (1832°F), quenched in a vacuum furnace and tempered 2 + 2h at 600°C (1110°F) to 45 ±1 HRC.

Temperature	20°C (68°F)	200°C (392°F)	400°C (750°F)	600°C (1010°F)
Density, kg/m³	7 800	7 750	7 700	7 600
lbs/in³	0.282	0.280	0.278	0.275
Modulus of elasticity MPa	210 000	200 000	180 000	140 000
psi	30.5 x 10^6	29.1 x 10^6	26.1 x 10^6	20.3 x 10^6
Coefficient of thermal expansion per °C from 20°C	–	11.6 x 10^{-6}	12.4 x 10^{-6}	13.2 x 10^{-6}
per °F from 68°F	–	6.4 x 10^{-6}	6.9 x 10^{-6}	7.3 x 10^{-6}
Thermal conductivity W/m °C	–	30	30	31
Btu in/(ft²h°F)	–	211	211	218

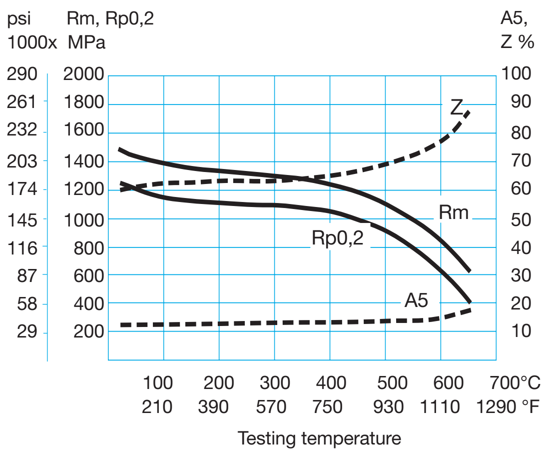
MECHANICAL PROPERTIES

Approximate tensile strength at room temperature.

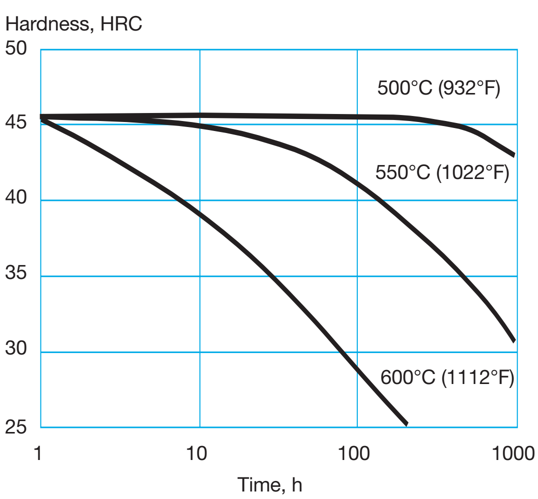
Hardness	45 HRC	46.5 HRC	48.5 HRC
Tensile strength R_m	1450 MPa 210 000 psi	1580 MPa 229 000 psi	1680 MPa 244 000 psi
Yield strength $R_p0,2$	1240 MPa 180 000 psi	1340 MPa 194 000 psi	1410 MPa 204 000 psi
Elongation A_5	13%	13%	12%
Reduction in area Z	65%	65%	64%

APPROXIMATE STRENGTH AT ELEVATED TEMPERATURES

Longitudinal direction.

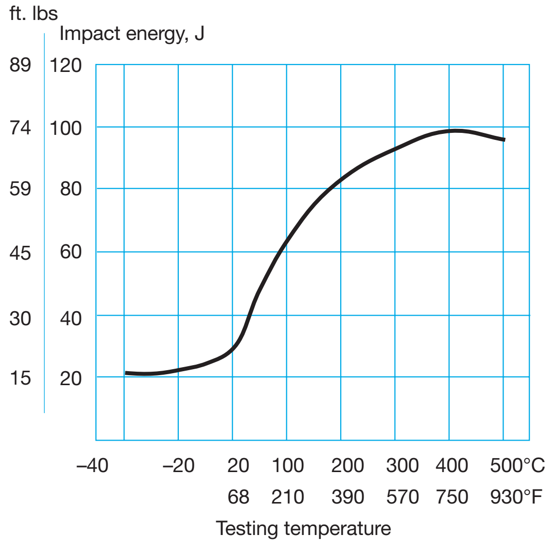


EFFECT OF TIME AT HIGH TEMPERATURES ON HARDNESS



EFFECT OF TESTING TEMPERATURES ON IMPACT ENERGY

Charpy V specimens, short transverse direction.



HEAT TREATMENT

SOFT ANNEALING

Protect the steel and hea t through to 850°C (1562°F). Then cool in furnace at 10°C (20°F) per hour to 650°C (1202°F), then freely in air.

STRESS RELIEVING

After rough machining the tool should be heated through to 650°C (1202°F), holding time 2 hours. Cool slowly to 500°C (932°F), then freely in air.

HARDENING

Preheating temperature: 600–900°C (1112–1652°F). Minimum two preheating steps at 600–650°C (1112–1202°F) and 820–850°C (1508–1562°F). When three preheats are used the second is carried out at 820°C (1508°F) and the third at 900°C (1652°F).

Austenitizing temperature: 980–1000°C (1796–1832°F).

Soaking time: 30–45 minutes.

Soaking time = time at austenitizing temperature after the tool is fully heated through.

Protect the tool against decarburization and oxidation during austenitizing.

QUENCHING MEDIA

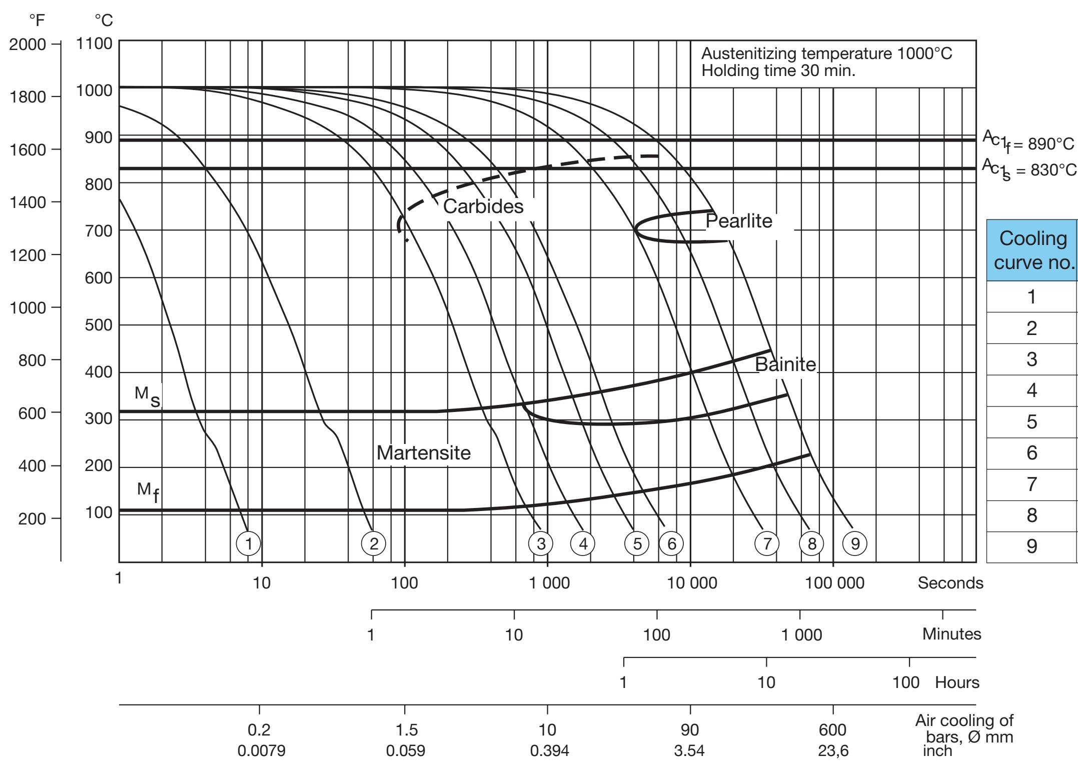
- High speed gas/circulating atmosphere.
- Vacuum (high speed gas with sufficient positive pressure). An interrupted quench at 350–450°C (662–842°F) is recommended where distortion control and quench cracking are a concern.
- Martempering bath (salt or fluidized bed) at 500–550°C (932–1022°F) or 180–220°C (356–428°F).
- Warm oil, approx. 80°C (176°F).

Note 1: Temper the tool as soon as its temperature reaches 50–70°C (122–158°F).

Note 2: In order to obtain the optimum properties for the tool, the cooling rate should be fast, but not at a level that gives excessive distortion or cracks.

CCT GRAPH

Austenitizing temperature 1000°C (1832°F). Holding time 30 minutes.



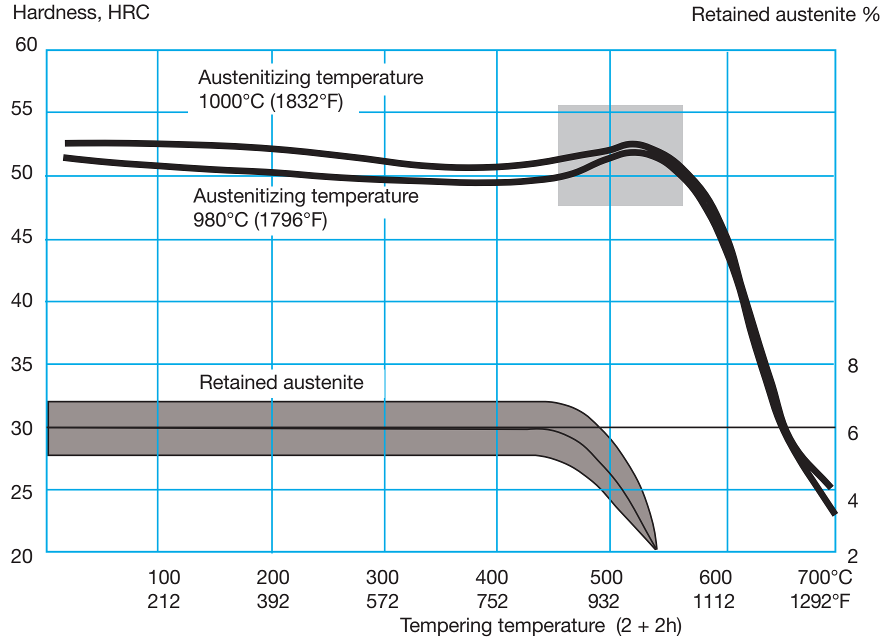
Cooling curve no.	Hardness HV10	T800-500 (sec)
1	657	1
2	642	10
3	592	140
4	585	280
5	585	630
6	579	1030
7	459	5200
8	446	10400
9	425	20800

TEMPERING

Choose the tempering temperature according to the hardness required by reference to the tempering graph below. Temper minimum twice with intermediate cooling to room temperature. Holding time at temperature is minimum 2 hours. Tempering in the temperature range 450–550°C (840–1020°F) for the intended final hardness will result in a lower toughness.

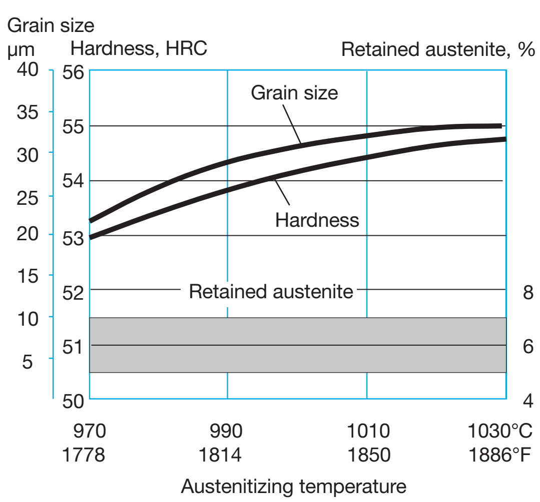
TEMPERING GRAPH

Air cooling of specimen 15 x 15 x 40 mm (0.6" x 0.6" x 1.6").



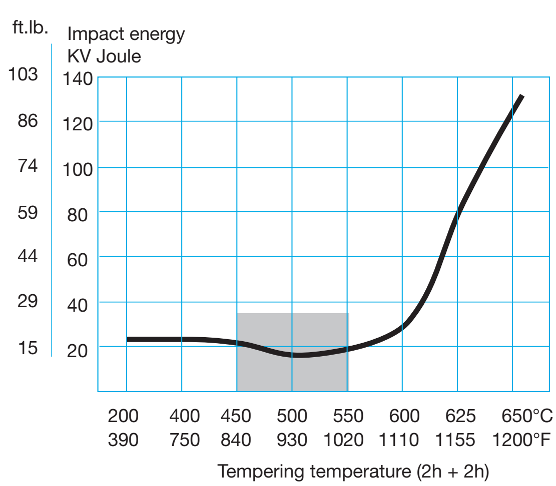
Above tempering curves are obtained after heat treatment of samples with a size of 15 x 15 x 40 mm, cooling in forced air. Lower hardness can be expected after heat treatment of tools and dies due to factors like actual tool size and heat treatment parameters.

HARDNESS, GRAIN SIZE AND RETAINED AUSTENITE AS A FUNCTION OF AUSTENI-TIZING TEMPERATURE



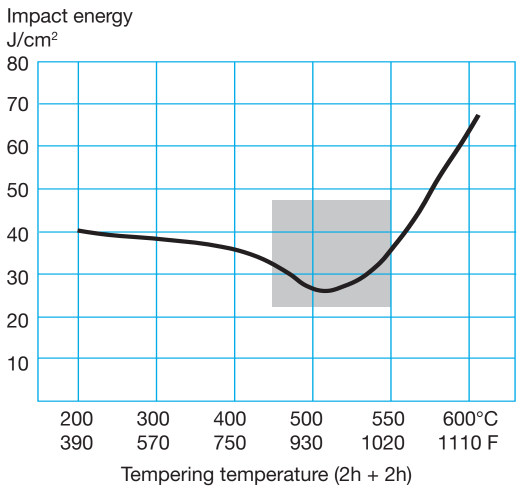
APPROXIMATE IMPACT ENERGY AT DIFFERENT TEMPERING TEMPERATURES

Charpy V specimens, short transverse direction.



Tempering in the temperature range 450–550°C (840–1020°F) for the intended final hardness will result in a lower toughness.

Charpy U specimens, short transverse direction.



DIMENSIONAL CHANGES DURING HARDENING AND TEMPERING

During hardening and tempering the die is exposed to thermal as well as transformation stresses. This will inevitably result in dimensional changes and in the work case distortion. It is therefore recommended to always leave a machining allowance after machining before the die is hardened and tempered. Normally the size in the largest direction will shrink and the size in the smallest direction might increase but this is also a matter of the die size, the die design as well as the cooling rate after hardening.

For Uddeholm Vidar Superior it is recom-mended to leave a machining allowance of
0.2 per cent of the dimension in length, width and thickness.

NITRIDING AND NITROCARBURIZING

Nitriding and nitrocarburizing result in a hard surface layer which is very resistant to wear and erosion. The nitrided layer is, however, brittle and my crack or spall when exposed to mechanical or thermal shock, the risk increasing with layer thickness. Before nitriding, the tool should be hardened and tempered at a temperature at least 50°C (120°F) above the nitriding temperature.

Nitriding in ammonia gas at 510°C (950°F) or plasma nitriding in 75% hydrogen / 25% nitrogen at 480°C (896°F) both result in a surface hardness of ~1100 $HV_{0,2}$.

In general, plasma nitriding is the preferred method because of better control over nitrogen potential; in particular, formation of the so-called "white layer", which is not recommended for hot-work service, can readily be avoided. However, careful gas nitriding can give perfectly acceptable results.

Uddeholm Vidar Superior can also be nitrocarburized in either gas or salt bath. The surface hardness after nitrocarburizing is 1000–1100 $HV_{0.2}$.

DEPTH OF NITRIDING

Process	Time	Depth mm	Depth inch
Gas nitriding at 510°C (950°F)	10 h 30 h	0.12 0.21	0.0047 0.0082
Plasma nitriding at 480°C (895°F)	10 h 30 h	0.10 0.19	0.0039 0.0075
Nitrocarburizing – in gas at 580°C (1075°F)	2.5 h	0.13	0.0051
– in salt bath at 580°C (1075°F)	1 h	0.07	0.0028

* Depth of case = distance from surface where hardness is 50 $HV_{0.2}$ over base hardness

Uddeholm Vidar Superior can also be nitrided in the soft annealed condition. The hardness and depth of case will, however, be reduced somewhat in this case.

CUTTING DATA RECOMMENDATIONS

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions. More information can be found in the Uddeholm publication "Cutting data recommendation".

The recommendations, in following tables, are valid for Uddeholm Vidar Superior in soft annealed condition.

TURNING

Cutting data parameters	Turning with carbide Rough turning	Fine turning	Turning with HSS Fine turning
Cutting speed (v_c) m/min f.p.m.	170–220 558–722	220–270 722–886	25–30 82–98
Feed (f) mm/rev. i.p.r.	0.2–0.4 0.008–0.016	0.05–0.2 0.002–0.008	–0.3 –0.012
Depth of cut (a_p) mm inch	2–4 0.08–0.16	0.5–2 0.02–0.08	–2 –0.08
Carbide designation ISO US	P20–P30 C6–C5 Coated carbide	P10 C7 Coated carbide or cermet	–

HSS = High Speed Steel

MILLING

FACE AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide Rough milling	Fine milling
Cutting speed (v_c) m/min f.p.m.	140–220 459–722	220–260 722–853
Feed (f_z) mm/tooth inch/tooth	0.2–0.4 0.008–0.016	0.1–0.2 0.004–0.008
Depth of cut (a_p) mm inch	2–4 0.08–0.16	–2 –0.08
Carbide designation ISO US	P20–P40 C6–C5 Coated carbide	P10 C7 Coated carbide or cermet

END MILLING

Cutting data parameters	Type of milling: Solid carbide	Carbide indexable insert	HSS
Cutting speed (v_c) m/min f.p.m.	145–185 476–607	150–190 492–623	30–35[1] 98–115[1]
Feed (f_z) mm/tooth inch/tooth	0.03–0.2[2] 0.001–0.008[2]	0.08–0.2[2] 0.003–0.008[2]	0.05–0.35[2] 0.002–0.013[2]
Carbide designation ISO US	–	P10–P20 C6–C5	–

[1] For coated HSS end mill v_c = 50–55 m/min. (164–180 f.p.m.)
[2] Depending on radial depth of cut and cutter diameter

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	inch	Cutting speed (v_c) m/min	f.p.m.	Feed (f) mm/rev.	i.p.r.
–5	–3/16	15–20*	49–66*	0.05–0.10	0.002–0.004
5–10	3/16–3/8	15–20*	49–66*	0.10–0.20	0.004–0.008
10–15	3/8–5/8	15–20*	49–66*	0.20–0.25	0.008–0.010
15–20	5/8–3/4	15–20*	49–66*	0.25–0.30	0.010–0.012

[1] For coated HSS drill v_c = 35–40 m/min. (115–131 f.p.m.)

CARBIDE DRILL

Cutting data parameters	Type of drill: Indexable insert	Solid carbide	Carbide tip[1]
Cutting speed (v_c) m/min f.p.m.	200–230 656–755	120–150 394–492	120–150 394–492
Feed (f) mm/rev. i.p.r.	0.05–0.15[2] 0.002–0.006[2]	0.10–0.25[3] 0.004–0.01[3]	0.15–0.25[4] 0.006–0.01[4]

[1] Drill with replaceable or brazed carbide tip
[2] Feed rate for drill diameter 20–40 mm (0.8"–1.6")
[3] Feed rate for drill diameter 5–20 mm (0.2"–0.8")
[4] Feed rate for drill diameter 10–20 mm (0.4"–0.8")

GRINDING

A general grinding wheel recommendation is given below. More information can be found in the Uddeholm publication “Grinding of Tool Steel”.

WHEEL RECOMMENDATION

Type of grinding	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	A 46 HV
Face grinding segments	A 24 GV	A 36 GV
Cylindrical grinding	A 46 LV	A 60 KV
Internal grinding	A 46 JV	A 60 IV
Profile grinding	A 100 IV	A 120 JV

ELECTRICAL DISCHARGE MACHINING – EDM

Following the EDM process, the applicable die surfaces are covered with a resolidified layer (white layer) and a rehardened and untempered layer, both of which are very brittle and hence detrimental to die performance.

If EDM is used the white layer must be completely removed mechanically by grinding or stoning. After the finish machining the tool should also then be given an additional temper at approx. 25°C (50°F) below the highest
previous tempering temperature.

Further information is given in the Uddeholm brochure “EDM of Tool Steel”.

POLISHING

Uddeholm Vidar Superior has good polishability in the hardened and tempered condition because of a very homogeneous structure. This coupled with a low level of non metallic inclusions, due to ESR process, ensures good surface finish after polishing.

Note: Each steel grade has an optimum polish-ing time which largely depends on hardness and polishing technique. Overpolishing can lead to a poor surface finish, “orange peel” or pitting.

Further information is given in the Uddeholm publication “Polishing of mould steel”.

PHOTO-ETCHING

Uddeholm Vidar Superior is particularly suitable for texturing by the photo-etching method. Its high level of homogeneity and low sulphur content ensures accurate and con-sistent pattern reproduction.

WELDING

Welding of die components can be performed, with acceptable results, as long as the proper precautions are taken during the preparation of the joint, the filler material selection, the preheating of the die, the controlled cooling of the die and the post weld heat treatment processes. The following guidelines summ-arize the most important welding process parameters.

For more detailed information refer to Uddeholm’s “Welding of Tool Steel” brochure.

Welding method	TIG	MMA
Preheating temperature*	Min. 325°C (620°F)	Min. 325°C (620°F)
Filler metals	DIEVAR TIG-WELD QRO 90 TIG-WELD	UTP 673 QRO 90 WELD
Maximum interpass temperature	475°C (880°F)	475°C (880°F)
Post welding cooling	20–40°C/h (35–70°F/h) for the first 2–3 hours and then freely in air.	
Hardness after welding	48–53 HRC	55–58 HRC (673) 48–53 HRC
Heat treatment after welding		
Hardened condition	Temper at 10–20°C (20–40°F) below the highest previous tempering temperature.	
Soft annealed condition	Soft-anneal the material at 850°C (1560°F) in protected atmosphere. Then cool in the furnace at 10°C (20°F) per hour to 650°C (1200°F) then freely in air.	

* Preheating temperature must be established throughout the die and must be maintained for the entirety of the welding process, to prevent weld cracking.

FURTHER INFORMATION

Please contact your local Uddeholm office for further information on the selection, heat treatment, application and availability of Uddeholm tool steel.

THE ESR TOOL STEEL PROCESS

The starting material for our tool steel is carefully selected from high quality recyclable steel. Together with ferroalloys and slag formers, the recyclable steel is melted in an electric arc furnace. The molten steel is then tapped into a ladle.

The de-slagging unit removes oxygen-rich slag and after the de-oxidation, alloying and heating of the steel bath are carried out in the ladle furnace. Vacuum de-gassing removes elements such as hydrogen, nitrogen and sulphur.

ESR PLANT

In uphill casting the prepared moulds are filled with a controlled flow of molten steel from the ladle.

From this, the steel can go directly to our rolling mill or to the forging press, but also to our ESR furnace where our most sophisticated steel grades are melted once again in an electro slag remelting process. This is done by melting a consumable electrode immersed in an overheated slag bath. Controlled solidification in the steel bath results in an ingot of high homogeneity, thereby removing macro segregation. Melting under a protective atmosphere gives an even better steel cleanliness.

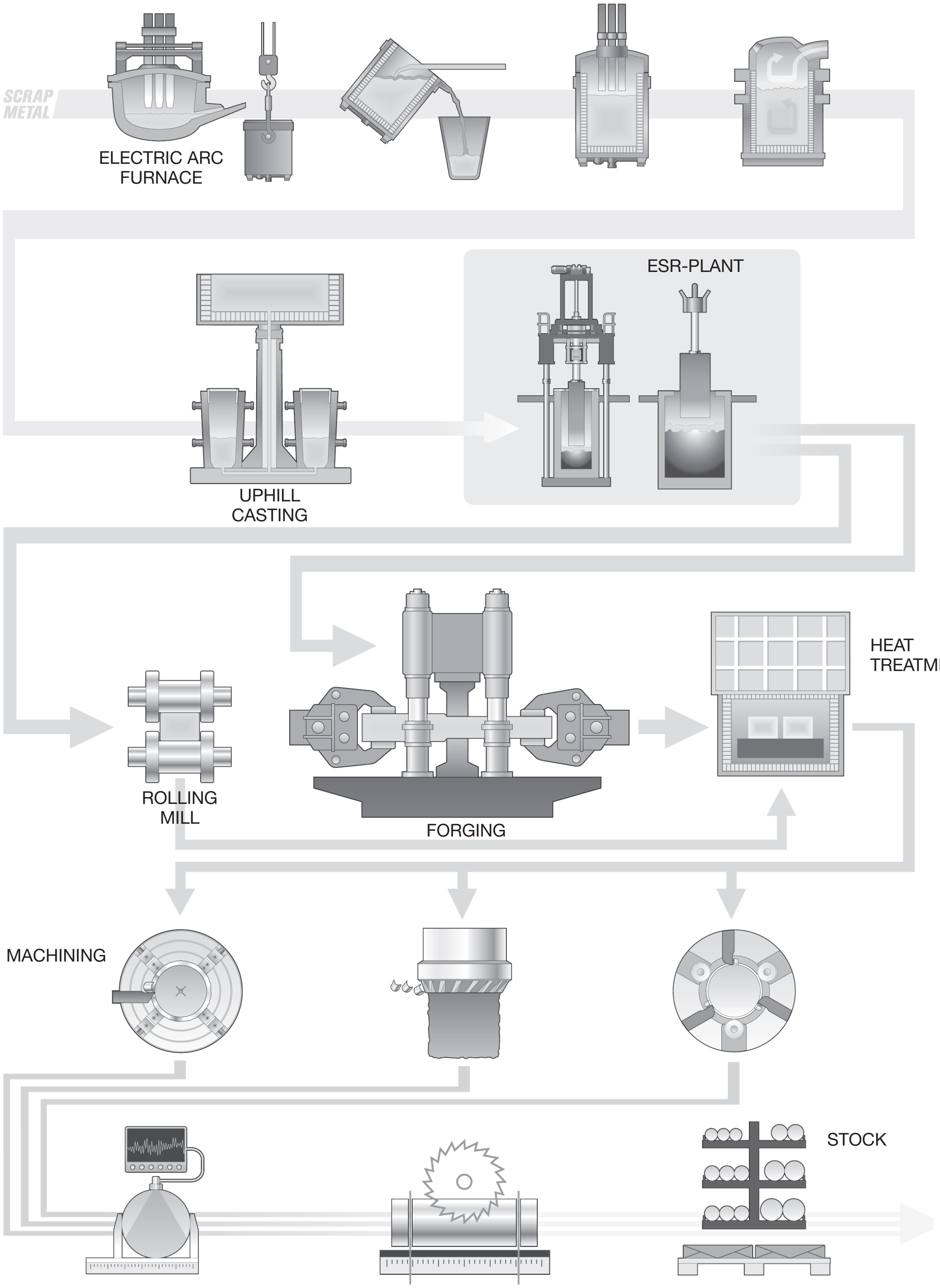
HOT WORKING

From the ESR plant, the steel goes to the rolling mill or to our forging press to be formed into round or flat bars. Prior to delivery all of the different bar materials are subjected to a heat treatment operation, either as soft annealing or hardening and tempering. These operations provide the steel with the right balance between hardness and toughness.

MACHINING

Before the material is finished and put into stock, we also rough machine the bar profiles to required size and exact tolerances. In the lathe machining of large dimensions, the steel bar rotates against a stationary cutting tool. In peeling of smaller dimensions, the cutting tools revolve around the bar.

To safeguard our quality and guarantee the integrity of the tool steel we perform both surface- and ultrasonic inspections on all bars. We then remove the bar ends and any defects found during the inspection.


SCRAP METAL
ELECTRIC ARC FURNACE
ESR-PLANT
UPHILL CASTING
HEAT TREATMENT
ROLLING MILL
FORGING
MACHINING
STOCK

Manufacturing solutions for generations to come

SHAPING THE WORLD®

We are shaping the world together with the global manufacturing industry. Uddeholm manufactures steel that shapes products used in our every day life. We do it sustainably, fair to people and the environment. Enabling us to continue shaping the world – today and for generations to come.

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