

X20NiCrAlMoV6-5-2-1* All

General Information

Hybrid Steel® is a low carbon steel containing a number of carefully controlled alloying elements, most importantly nickel, chromium, aluminium, molybdenum and vanadium. These enable it to develop its full properties after aging at elevated temperature (500–620°C). The chromium and aluminium content also improves corrosion resistance. The variant 297A is offered under the name Hybrid Steel 55 and the variant 397A is offered under the name Hybrid Steel 60.

Hybrid Steel 55 - Engineering steel.

Hybrid Steel 60 - Bearing steel.

Maximum hardness after aging: Hybrid Steel 55, 55HRC. Hybrid Steel 60, 60HRC.

Hybrid Steel offers superior mechanical and fatigue strength compared to conventional steel grades at elevated temperatures.

- Excellent elevated temperature strength
- Flexible hardness, achieved by an aging treatment in the temperature range 500–620°C
- Extremely good dimensional stability when aging is applied
- High uniformity of properties also for large components
- Good weldability, no preheating necessary
- Corrosion resistance comparable to AISI 440C

The density for these grades is 7582 kg/m³.

* Designation followed by "" is not an official EN standard grade but named according to the rules in EN 10027.

Similar designations

X20NiCrAlMoV6-5-2-1, X30NiCrAlMoV6-5-2-1, Ovako297A, Ovako397A

Chemical composition

Variant	Cast		C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	V %	Al %
Hybrid Steel 55, 297A	IC	Mn	0.16	-	0.20	-	-	4.80	5.80	0.60	0.450	2.000
		Max	0.20	0.20	0.40	0.015	0.001	5.20	6.20	0.80	0.550	2.400
Hybrid Steel 60, 397A	IC	Mn	0.25	-	0.20	-	-	4.80	5.80	0.60	0.450	2.000
		Max	0.31	0.20	0.40	0.015	0.001	5.20	6.20	0.80	0.550	2.400

Mechanical Properties

Variant	Condition	Format	Yield strength min [MPa]	Tensile strength [MPa]	Elongation A ₅ [%]	Reduction of area Z _{min} [%]
Hybrid Steel 55, 297A	+AG, at RT	All formats	1706	1890 typical	10	36
	+AG, at 150°C	All formats	1605	1782 typical	8.6	21
	+AG, at 250°C	All formats	1514	1715 typical	10.1	51
	+AG, at 350°C	All formats	1420	1610 typical	10.3	55
	+AG, at 450°C	All formats	1280	1410 typical	10.3	59
	+AG, at 550°C	All formats	930	1056 typical	10.1	63

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Aging at 580°C for 3 hours, Hardness 56 HRC. Test temperature: RT to 550°C.

Transformation temperatures

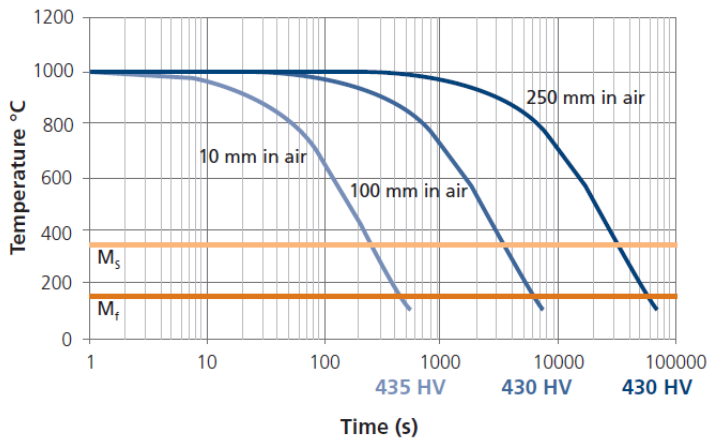
	Temperature °C
MS	350
AC1	800
AC3	950

Transformation temperatures for Hybrid 55 above. AC3 for Hybrid Steel 60 is 1020°C. Ms is 150°C for both grades.

Heat treatment recommendations

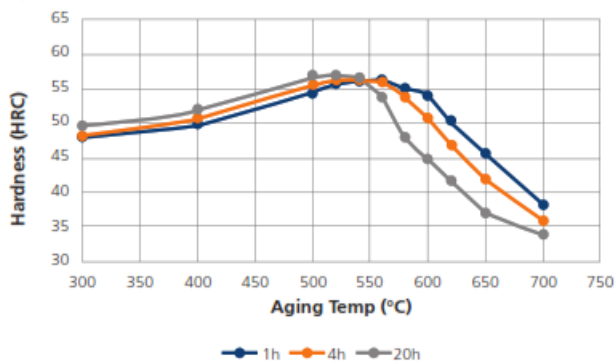
Treatment	Condition	Temperature cycle	Cooling/quenching
As-rolled	+AR	Hybrid steel 55, Hardness 450HV	
Soft annealing	+A	Hybrid Steel 55, 800°C/3h, Hardness 260HV	Slow cooling from 800°C to 600°C, <20°C/h
Hardening	+Q	Hybrid Steel 55, 950°C /45 min, Hardness 450HV	Air cool or quench in oil
Aging	+AG	Hybrid Steel 55, 500-620°C 1-20h. Hardness 400-600HV	
As-rolled	+AR	Hybrid Steel 60, Hardness 550HV	
Soft annealing	+A	Hybrid Steel 60, 800°C/3h, Hardness 300HV	Slow cool from 800°C to 600°C <20°C/h
Hardening	+Q	Hybrid Steel 60, 1020°C/45 min, Hardness 550HV	Air cool or quench in oil
Aging	+AG	Hybrid Steel 60, 500-620°C 1-20h, Hardness 430-700HV	

Hybrid Steel 55 and 60

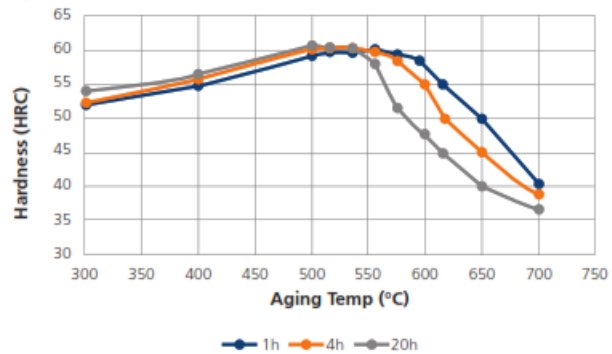


Aging Characteristics

Hybrid Steel 55. Hardened. 950°C/45min.

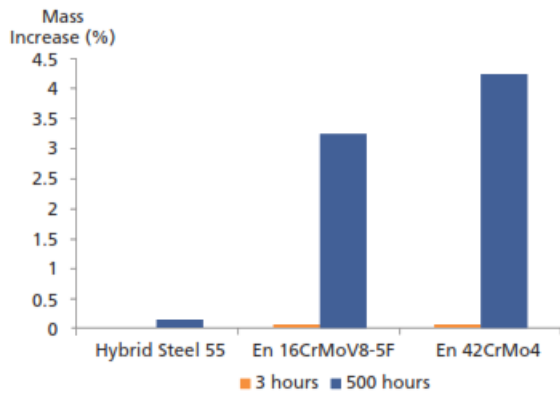


Hybrid Steel 60. Hardened. 1020°C/45min.



Oxidation Resistance

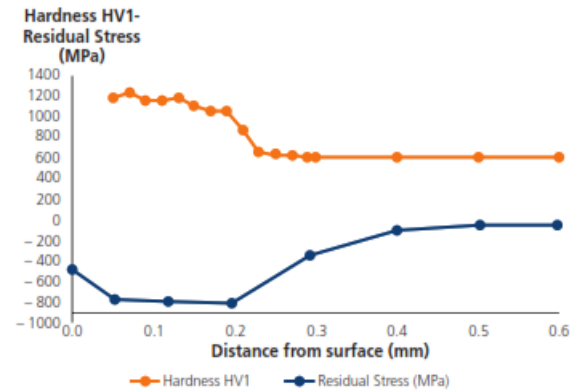
Heating in air, 700°C.



Nitriding

Hybrid Steel 55. Aged to 55 HRC.

Plasma Nitrided at 520°C for 20 hours.



Welding

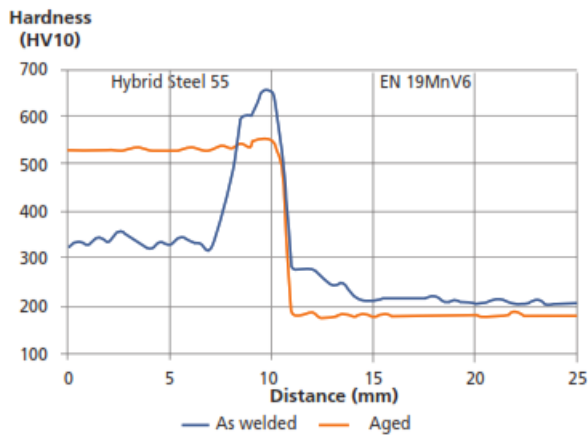
Friction welding. One piece rotating and one static.

Bar diameter 25 mm

Initial heating (22 bar)

Max temperature (56 bar)

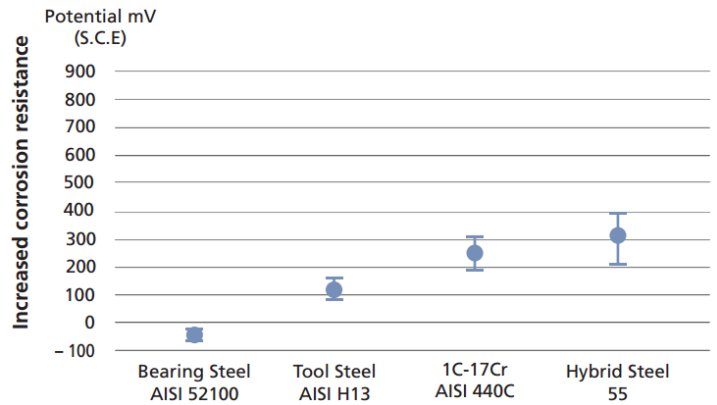
Friction weld (79 bar)



Corrosion Resistance

ISO 15158 Corrosion of metals and alloys.

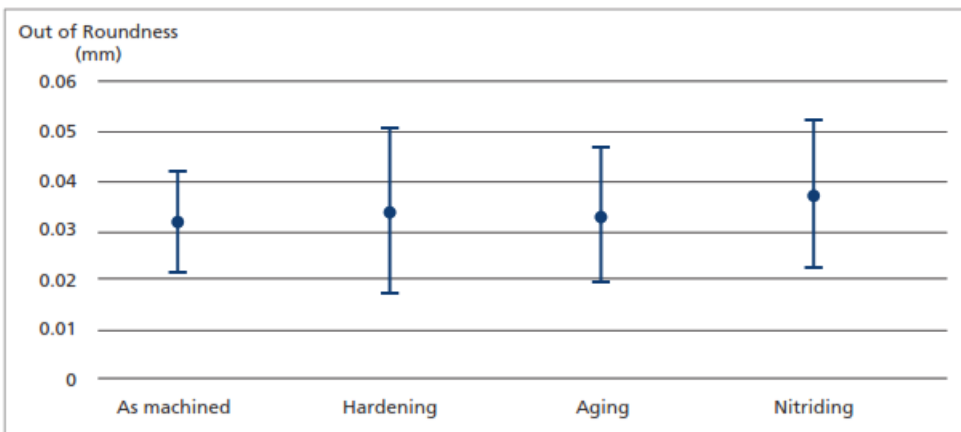
10mV/min in 0.01M NaCl.



Distortion Hybrid Steel 55

Rings with dimension 140*120*20 mm were machined from soft annealed Hybrid steel 55.

Out of roundness was measured after each process step.



Machining recommendations Hybrid Steel 55

Soft annealed Hybrid Steel 55 (260HV).

Turning

	Insert/tool	Cutting speed v_c (m/min)	Feed rate f_n (mm/rev)	Cutting depth a_p (mm)
Rough/medium	RCMT1204 medium ISO-M15	140–175	0.35–0.6	2–4
	CNMG120412 medium ISO-M15	150–175	0.30–0.40	2–4
Fine	CNMG120408 medium ISO-M15	160–180	0.25–0.40	1.5–2.5
	CNMG120404 fine ISO-M15	160–180	0.15–0.30	0.5–1.5

Drilling

Tool	Diameter \varnothing (mm)	Cutting speed v_c (m/min)	Feed rate f_n (mm/rev)	Depth (mm)
Mitsubishi MVX2500X6F25 insert SOMX084005-UM VP15TF	25	100	0.18	5 x \varnothing
Mitsubishi STAWMN1600S20 insert STAWN1600T VP15TF	16	55	0.30	5 x \varnothing
Mitsubishi MPS1-0800-PC	8	100	0.27	2 x \varnothing
Mitsubishi MPS1-0800-L20C	8	70	0.27	20 x \varnothing
Mitsubishi MPS1-0400-PC	4	80	0.15	2 x \varnothing
Mitsubishi MPS1-0400-L30C	4	60	0.18	20 x \varnothing

Thermal Properties

Hybrid Steel 55. Aged at 580°C for 3 hours.
56HRC

(in aged condition)		RT	100°C	200°C	300°C	400°C	500°C
Linear Thermal Expansion	$10^{-6} \text{ } ^\circ\text{C}^{-1}$		11.6	12.0	12.4	12.7	13.1
Thermal Conductivity	$\text{W m}^{-1} \text{ } ^\circ\text{C}^{-1}$	18.4	21.0	22.5	24.1	24.9	26.1
Thermal Diffusivity	$10^{-6} \text{ m}^2 \text{ s}^{-1}$	5.37	5.56	5.69	5.67	5.54	5.28
Specific Heat	$\text{J g}^{-1} \text{ } ^\circ\text{C}^{-1}$	0.45	0.49	0.53	0.56	0.60	0.66

Other properties (typical values)

Youngs module (GPa)	Poisson's ratio (-)	Shear module (GPa)	Density (kg/m ³)
210	0.3	80	7800
Average CTE 20-300°C ($\mu\text{m/m}^\circ\text{K}$)	Specific heat capacity 50/100°C ($\text{J/kg}^\circ\text{K}$)	Thermal conductivity Ambient temperature ($\text{W/m}^\circ\text{K}$)	Electrical resistivity Ambient temperature ($\mu\Omega\text{m}$)
12	460 - 480	40 - 45	0.20 - 0.25

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