

# 16NiCrS4 All

## General Information

16NiCrS4 is an case hardening steel with good dimension stability, high toughness and improved machinability.

Ovako 146S is an ingot cast steel. The chemical composition is well controlled to give the steel a controlled hardenability towards the high end (HH). It has reduced silicon content for reduced propensity for internal oxidation during carburizing. Regulated sulphur content ensures good machinability properties.

4730 is an contious cast steel. The chemical composition is well controlled to give the steel a controlled hardenability towards the low end (HL). For improved machinability this steel is processed according to our M-Steel concept.

## M-Steel®

The basis for the concept is that non-metallic inclusions are modified and controlled with calcium treatment in a way to minimize tool wear and to maximize chip control in machining operations. Our M-Steel treatment can be applied to any steel grade.

## Similar designations

SS 2511, 16NCD5 (AFNOR), 637 A 16 (BS), 16NC6 (AFNOR), BS 637M17 M

## Chemical composition

Variant	Cast	Weldability		C %	Si %	Mn %	P %	S %	Cr %	Ni %	Mo %	Cu %
146S	IC	CEV 0.81 <sub>max</sub>	Min	0.13	0.05	0.70	-	0.035	0.60	0.80	0.05	-
		Pcm 0.4 <sub>max</sub>	Max	0.25	0.15	1.10	0.025	0.050	1.20	1.40	0.20	-
4730	CC	CEV <sub>max</sub>	Min	0.13	0.10	0.70	0.000	0.010	0.60	0.80	-	-
		Pcm <sub>max</sub>	Max	0.19	0.25	1.00	0.035	0.040	1.00	1.10	-	-
EN ISO 683-3 16NiCrS4	Std	CEV 0.67 <sub>max</sub>	Min	0.13	0.15	0.70	-	0.020	0.60	0.80	-	-
		Pcm 0.33 <sub>max</sub>	Max	0.19	0.40	1.00	0.025	0.040	1.00	1.10	-	0.40

Mechanical Properties

Variant	Condition ⓘ	Format	Dimension [mm]	Yield strength min [MPa]	Tensile strength [MPa]	Elongation A <sub>5</sub> [%]	Hardness
146S	+U	Round bar	24 < 190	650*	840 typical	15	260 HB typical
	+A	Round bar	24 < 190	-	-	-	170 HB typical
	+Q	Round bar	< 30	490*	800-1200	8	260-380 HB
4730	+AR	Round bar	25 < 160	-	-	-	< 250 HB

*R<sub>p0.2</sub>* \* *R<sub>eh</sub>*, \*\* *R<sub>el</sub>*

Transformation temperatures

	Temperature °C
AC1	714
AC3	799

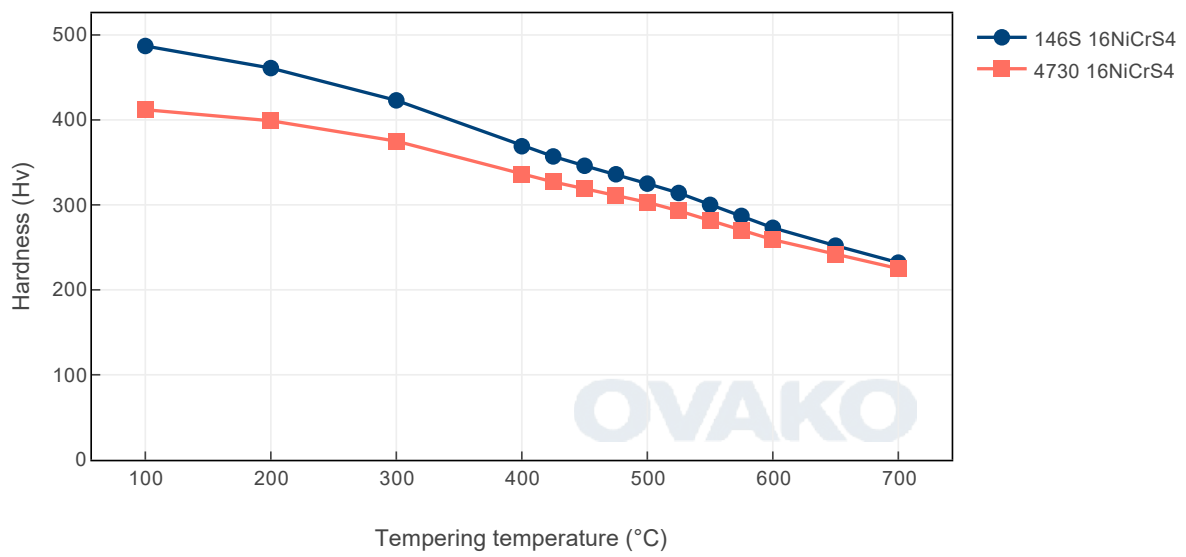
Heat treatment recommendations

Treatment	Condition ⓘ	Temperature cycle	Cooling/quenching
Hot forging	+AR	Soaking at 800 - 1200°C	In air
Normalizing	+N	860 - 890°C	In air
Soft annealing	+A	600 - 670°C / 2h	In air
Quenching	+Q	Hardening temperature 840 - 890°C	In oil
Carburizing	+Q	Hardening as carburized soaking 780 - 830°C	In oil
Tempering	+QT	Soaking at 160 - 250°C 1hr	In air

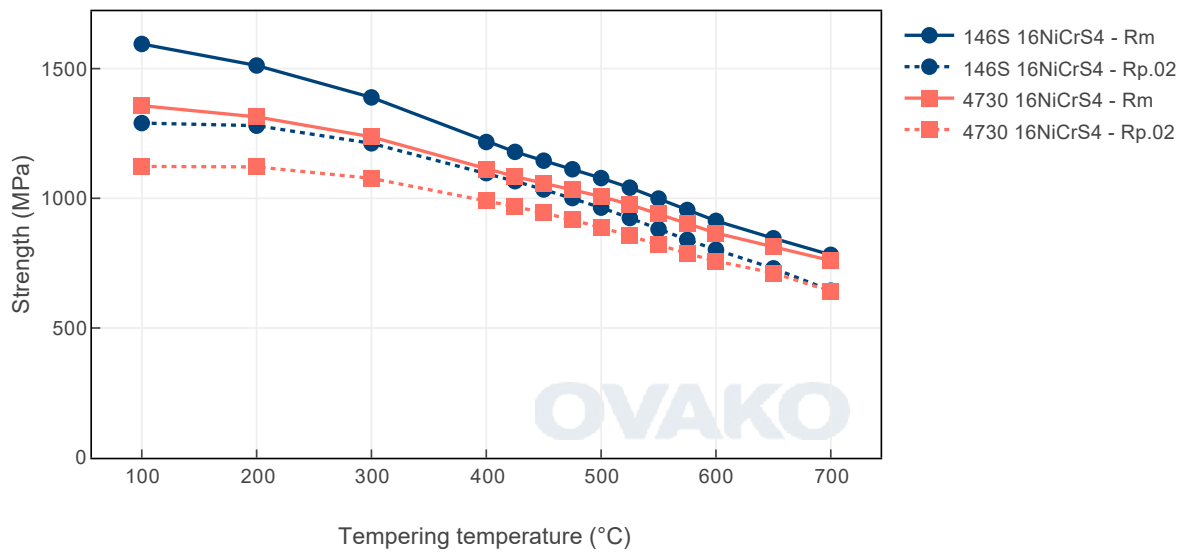
Heat Treatment Guide generated Graphs

The following graphs are generated from a theoretical model. For further info see the Heat treatment guide module. Select a specific grade version for individual display.

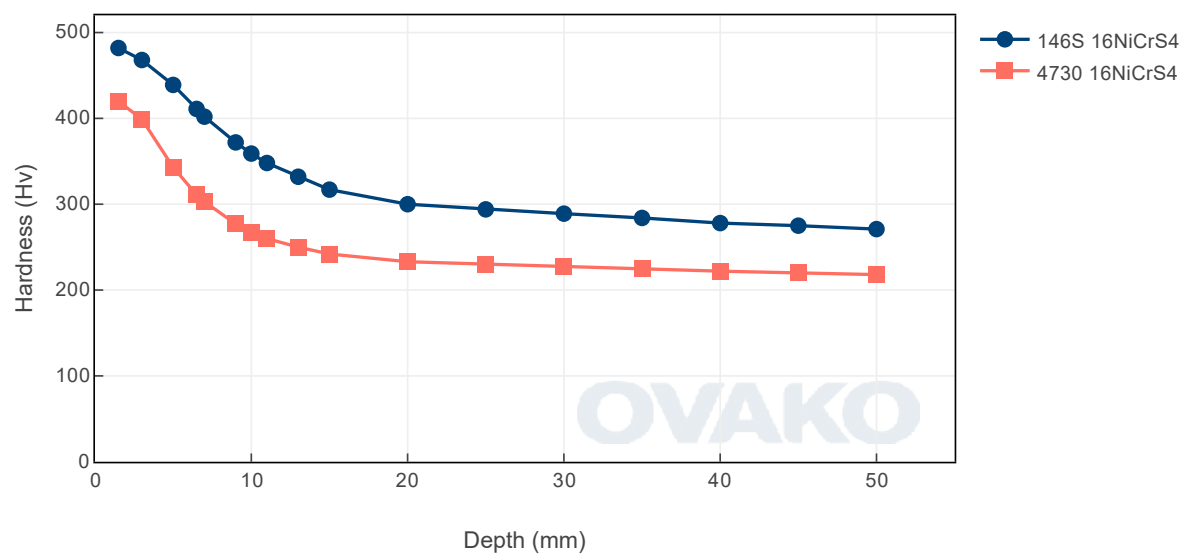
Tempering Diagram (hardness)



Tempering Diagram (strength)

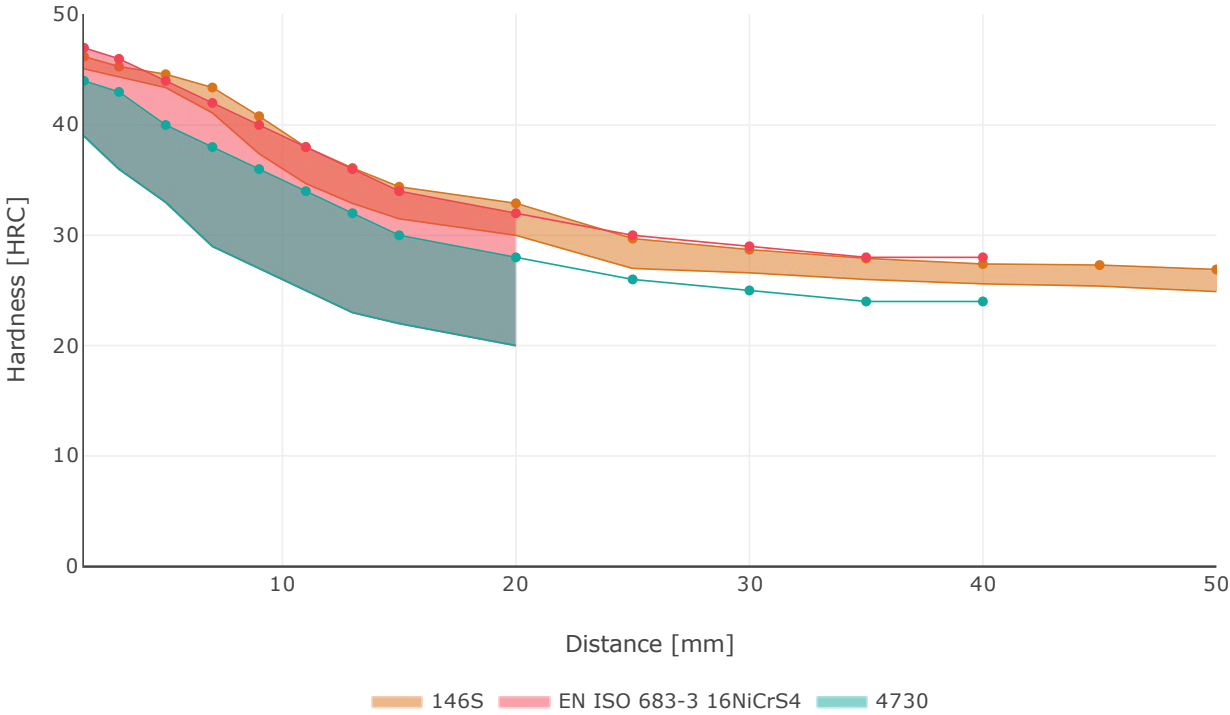


# Jominy





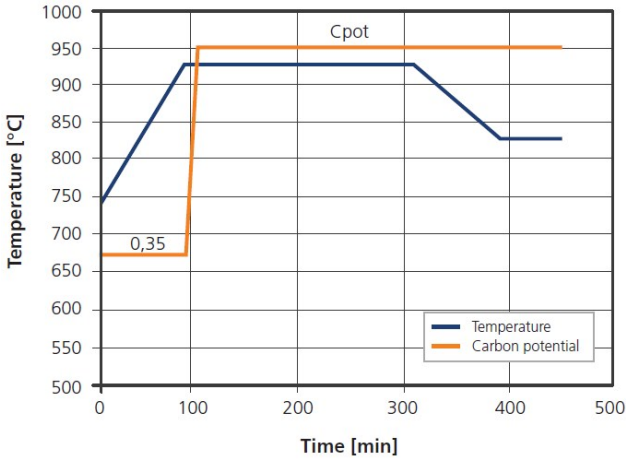
Hardenability



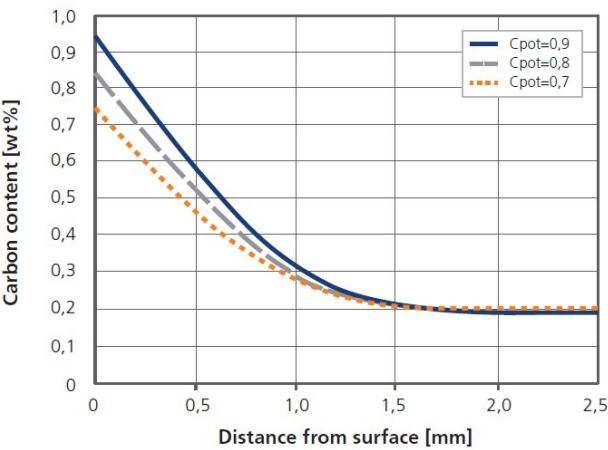
146S: Jominy hardenability according to ASTM A255. Average value with +/- standard deviation.

EN ISO 683-3 data is showing the +H version.

Heat treatment

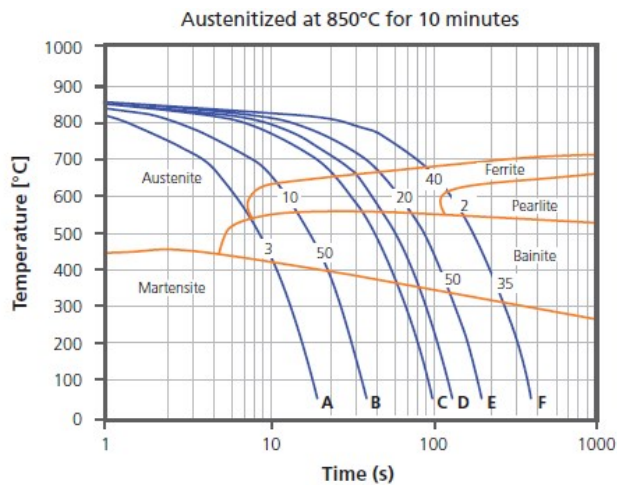


Carburizing response



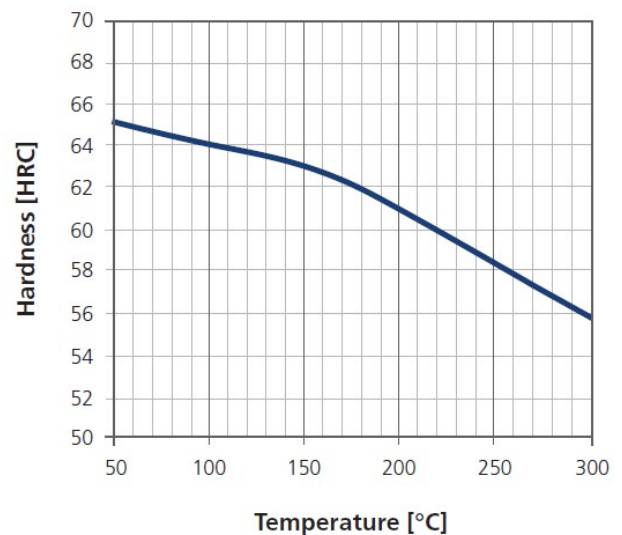
Carburization response for Ovako 146S for the cycles shown in the left figure.

## CCT



	A	B	C	D	E	F
$t_{8-5}$ [s]	7.5	15	37.5	50	75	150
HV <sub>30</sub>	455	345	320	290	285	255

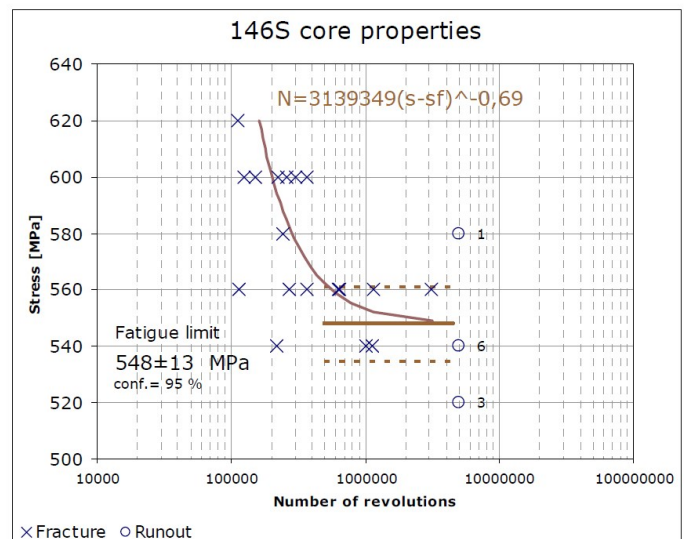
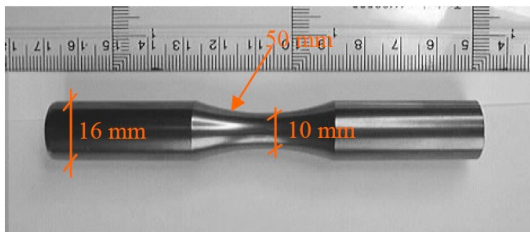
## Tempering response



Tempering response for carburized surfaces of Ovako 146S after quenching and tempering one hour at different temperatures.

## Fatigue properties

Test method:	Rotating beam
Test procedure:	Stair-case 20 MPa steps
Specimen:	Hourglass shape Ø 10 mm
Heat treatment:	Simulated core structure 925°C / 8h 820°C / 0.5h Oil quench 150°C / 1.5h
Hardness:	40 HRC



## Steel cleanliness

Micro inclusions								Macro inclusions	
Applied standard	ASTM E45							Applied standard	ISO 3763 (Blue fracture)
Sampling	ASTM A295							Sampling	Statistical testing on billets
Maximum average	A		B		C		D	Limits	< 5 mm/dm <sup>2</sup>
limits	Th	He	Th	He	Th	He	Th		
	2,5	1,5	1,0	0,5	0	0	0,5		

## SUSTAINABILITY-ENVIRONMENTAL IMPACT DATA

At Ovako sustainability and reduction of our environmental impact is a major focus in everything we do.

Further information is found [here](#).

Steel works	Hofors	Smedjebacken	Imatra
CO <sub>2</sub> e/kg	120	62	76

To get the full picture of our products environmental impact we have to look at all of our CO<sub>2</sub> emission sources.

Not only the steel work Scope 1-2 itself, but all operations downstream in our production, heating and heat treatment furnaces etc (full scope 1-2) as well as all the emission from input material, eg. alloys, scope 3.

Steel Grade	Format	Condition	Scope 1-3 (CO <sub>2</sub> e kg /1000 kg steel)	Climate compensated Net emission = Scope 3 (CO <sub>2</sub> e kg /1000 kg steel) Scope 1 - 2 = 0 (compensated)
146S	Round bar	+AR	795	396
146S	Round bar	+FP	800	399
146S	Tube,wall	+AR	833	436
146S	Tube,wall	+FP	836	438
4730	Round bar	+AR	649	345

To get the full picture of our products environmental impact we have to look at all of our CO<sub>2</sub> emission sources.

Not only the steel work Scope 1-2 itself, but all operations downstream in our production, heating and heat treatment furnaces etc (full scope 1-2) as well as all the emission from input material, eg. alloys, scope 3.

### Other properties (typical values)

Youngs module (GPa)	Poisson 's ratio (-)	Shear module (GPa)	Density (kg/m <sup>3</sup> )
210	0.3	80	7800
Average CTE 20-300°C (µm/m°C)	Specific heat capacity 50/100°C (J/kg °K)	Thermal conductivity Ambient temperature (W/m°C)	Electrical resistivity Ambient temperature (µΩm)
12	460 - 480	40 - 45	0.20 - 0.25

### Contact us

Would you like to know more about our offers? Don't hesitate to contact us:

Via e-mail: [info@ovako.com](mailto:info@ovako.com)

Via telephone: +46 8 622 1300

For more detailed information please visit <http://www.ovako.com/en/Contact-Ovako/>

### Disclaimer

*The information in this document is for illustrative purposes only. The data and examples are only general recommendations and not a warranty or a guarantee. The suitability of a product for a specific application can be confirmed only by Ovako once given the actual conditions. The purchaser of an Ovako product has the responsibility to ascertain and control the applicability of the products before using them. Continuous development may necessitate changes in technical data without notice. This document is only valid for Ovako material. Other material, covering the same international specifications, does not necessarily comply with the properties presented in this document.*