

# NAS HX (UNS N06002)

## NAS Heat-Resistant Nickel Alloy

NAS HX (UNS N06002) is a nickel-chromium-iron-molybdenum alloy with outstanding strength and oxidation resistance in temperatures reaching as high as 1200°C. With superior workability and weldability as well, it is excellent for use in gas turbine members as well as various heating furnace parts. Nippon Yakin supplies this product in plate, sheet, and strip forms.

### Grade/Standard

NAS	JIS H4551	ASTM B435	AMS 5536
NAS HX	NW 6002	UNS N06002	5536L

### Chemical Composition

	C	Si	Mn	P	S	Ni	Cr	Mo	Co	Al	Ti	Cu	W	Fe	B
Specification (NW 6002)	0.05~0.15	≦1.0	≦1.0	≦0.040	≦0.030	Balance	20.5~23.0	8.0~10.0	0.5~2.5	—	—	—	0.2~1.0	17.0~20.0	≦0.010
Specification (UNS N06002)	0.05~0.15	≦1.00	≦1.00	≦0.04	≦0.03	Balance	20.5~23.0	8.0~10.0	0.5~2.5	—	—	—	0.2~1.0	17.0~20.0	—
Specification* (UNS N06002)	0.05~0.15	≦1.00	≦1.00	≦0.040	≦0.030	Balance	20.50~23.00	8.00~10.00	0.50~2.50	≦0.50	≦0.15	≦0.50	0.20~1.00	17.00~20.00	≦0.010

\*AMS 5536L

### Physical Properties

Density	[g/cm <sup>3</sup> ]	8.20
Specific heat	[J/kg · K]	434
Electrical resistivity	[μΩ · cm]	113
Thermal conductivity	[W/m · K]	10.5
Average coefficient of thermal expansion [10 <sup>-6</sup> /°C]	25~ 200°C	13.9
	25~ 400°C	14.5
	25~ 600°C	15.0
	25~ 800°C	15.9
	25~1000°C	16.7
Young's modulus	[MPa]	19.5 × 10 <sup>4</sup>
Magnetism		None
Melting range	[°C]	1290~1365

Mechanical Properties

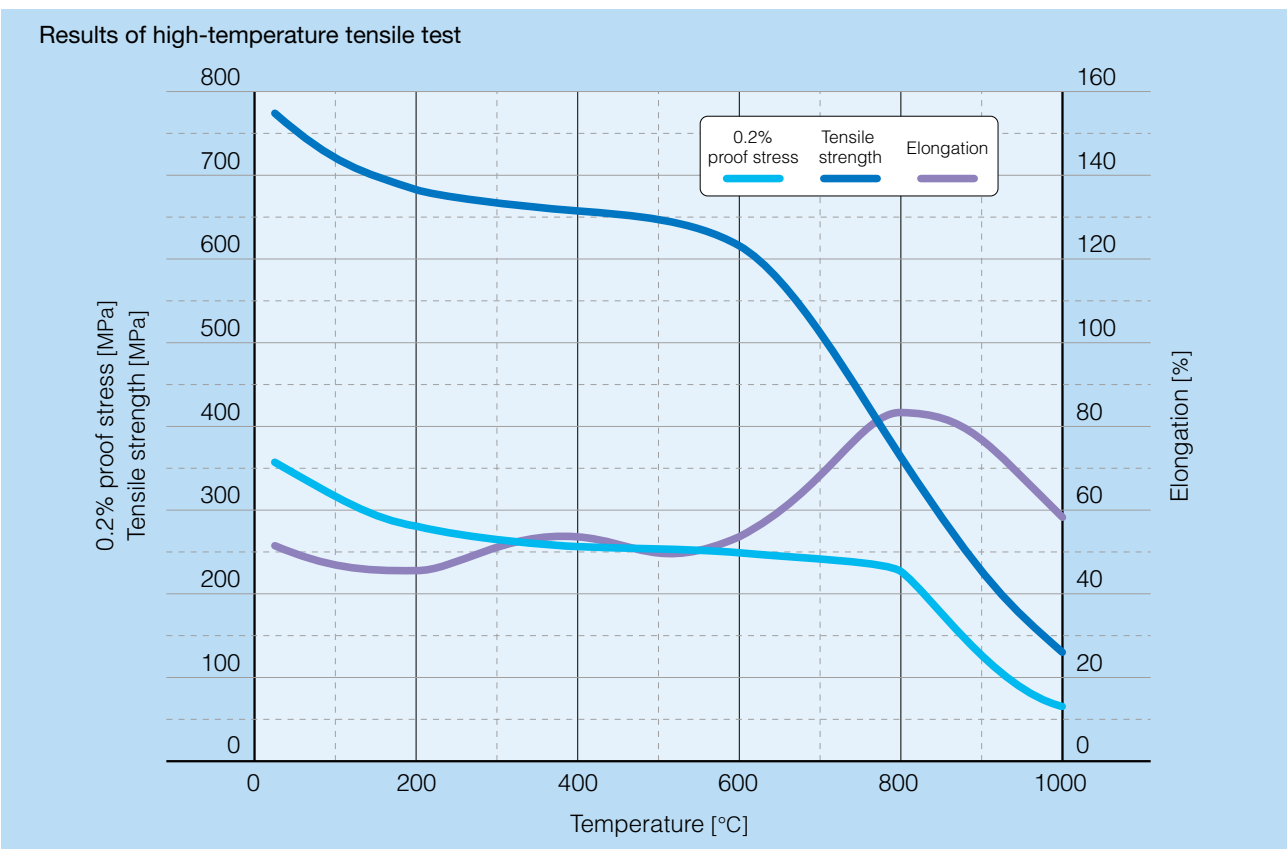
Mechanical Properties at Room Temperature

		0.2% proof stress [MPa]	Tensile strength [MPa]	Elongation [%]	Hardness	
					[Hv]	[HB]
Specification (NW 6002)		≥ 245	≥ 660	≥ 35	—	—
Specification (UNS N06002)		≥ 240	≥ 655	≥ 35	—	—
Specification (SAE AMS 5536L)		≥ 310	≥ 724	≥ 35	—	—
Example	Hot-rolled plate 6mm <sup>t</sup>	388	772	40	—	204
	Cold-rolled sheet 1.2mm <sup>t</sup>	369	777	45	183	—

Impact Value

	Aging treatment	Test temperature [°C]	Impact value [J/cm <sup>2</sup> ]
Solution-treated NAS HX	Not applied	-196	138
	Not applied	-78	162
	Not applied	Room temp.	184
NAS HX solution treated, then aged	816°C for 50hr	Room temp.	53
	816°C for 150hr	Room temp.	45
	816°C for 500hr	Room temp.	41

High Temperatures Strength



Creep Properties

		Test temperature [°C]	Load [MPa]	Rupture time [hr]	Rupture elongation [%]
Specification (SAE AMS 5536L)		816	110	≥24	≥8
Example	Hot-rolled plate 35mm <sup>t</sup>	816	110	63	76
	Hot-rolled plate 12mm <sup>t</sup>	816	110	77	97
	Cold-rolled sheet 3mm <sup>t</sup>	816	110	93	79
	Cold-rolled sheet 1.2mm <sup>t</sup>	816	110	67	74

Formability

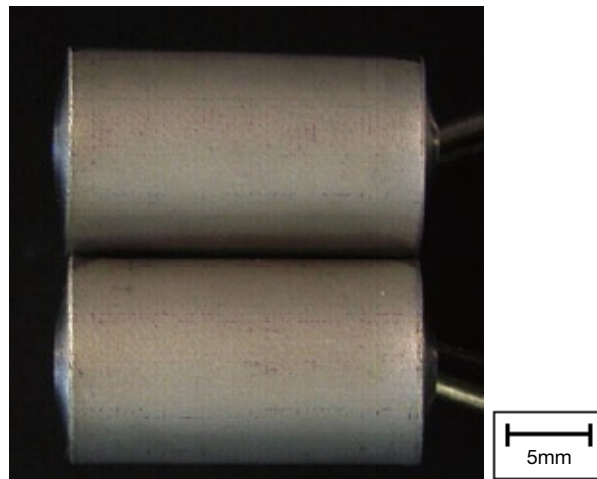
Formability

A formability test was performed on a sheet of solution-treated NAS HX 1.5mm thick with number 2B finish. NAS HX is easily formed with cold working.

	Erichsen value [mm]	Limited drawing ratio
NAS HX	10.3	2.10

Bendability

A 180° bending test to demonstrate the bending radius 2t (t being the nominal thickness) was performed on a sheet of solution-treated NAS HX 3mm thick with number 2B finish.



No cracking

**Workability**

We recommend using a range of 982 to 1177°C for hot working NAS HX. NAS HX can also be easily cold worked. Note that a greater force is required to work NAS HX than standard austenitic stainless steels. Solution treatment should be applied after working to obtain favorable creep properties.

**Weldability**

Such techniques as TIG, MIG and shield metal arc welding can be used for NAS HX as with standard austenitic stainless steels. Before welding, the weld surface should be cleaned off oxidizing scales as well as oil and dirt.

**Heat Treatment**

The recommended solution heat treatment temperature is between 1149 and 1177°C, the range stipulated in SAE AMS 5536L. Rapid cooling is required after heat treatment to prevent precipitates.

**Applications**

Gas turbine heat chambers; afterburner tail pipes and other components; heating furnace fans, rollers, trays, hardware, and other parts

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**Note regarding the handling of property data:**

The technical information contained in this product guide is representative values obtained in property tests and other items used to explain the performance of the product. With the exception of items specifically mentioned as provisions of a "Standard," the contents do not represent guaranteed upper limit or lower limit values. The respective data given on this technical information are typical examples and may be different in some cases from the data obtained from the actual product. No responsibility shall, therefore, be assumed for damages arising from using the technical information data. This information is also subject to change in the future without notice. To obtain the most recent information, please contact Nippon Yakin.