

# NAS NW22 (UNS N06022)

## NAS High Corrosion Resistant Nickel Alloy

NAS NW22 is a Ni-Cr-Mo alloy with excellent corrosion resistance. This alloy provides excellent pitting corrosion resistance, crevice corrosion resistance, and stress corrosion cracking resistance in both oxidizing and reducing environments, and is widely used as a material under severe environments such as flue gas desulfurization plants, papermaking processes, waste treatment processes, etc.

Nippon Yakin supplies this product in plate, sheet and strip forms.

### Grade/Standard

NAS	JIS H4551	ASTM B575	DIN 17744/17750
NAS NW22	NW6022	UNS N06022	2.4602

### Chemical Composition

	C	Si	Mn	P	S	Ni	Cr	Mo	Fe	Co	W	V
Specification (NW6022)	≤0.015	≤0.08	≤0.5	≤0.025	≤0.020	Balance	20.0~22.5	12.5~14.5	2.0~6.0	≤2.5	2.5~3.5	≤0.35
Specification (UNS N06022)	≤0.015	≤0.08	≤0.50	≤0.02	≤0.02	Balance	20.0~22.5	12.5~14.5	2.0~6.0	≤2.5	2.5~3.5	≤0.35

### Physical Properties

Density	[g/cm <sup>3</sup> ]	8.70
Specific heat	[J/kg · K]	414
Electrical resistivity	[μΩ · cm]	114.0
Thermal conductivity	[W/m · K]	10.0
Average coefficient of thermal expansion [10 <sup>-6</sup> /°C]	20~100°C	11.5
	20~200°C	12.7
	20~300°C	13.0
	20~400°C	13.5
	20~500°C	13.8
Young's modulus	[MPa]	20.4 × 10 <sup>4</sup>
Magnetism		None
Melting range	[°C]	1325~1372

Mechanical Properties

		0.2% proof stress [MPa]	Tensile strength [MPa]	Elongation [%]	Hardness [HRB]
Specification (NW6022)		≥ 310	≥ 690	≥ 45	—
Specification (UNS N06022)		≥ 310	≥ 690	≥ 45	≤ 100
Example	Hot-rolled plate sheet 12mm <sup>t</sup>	367	744	73	84
	Cold-rolled sheet 3mm <sup>t</sup>	383	782	57	86

Corrosion Resistance

Pitting Corrosion Resistance

Alloy	ASTM G48 Method A		ASTM G48 Method C
	22°C	50°C	Critical pitting corrosion temperature CPT (°C)
NAS 185N	○	○	70
NAS 254N	○	○	80
NAS NW22	○	○	>103

Test conditions ASTM G48 Method A (○: No pitting corrosion, ×: Pitting corrosion)

- Test solution: 6%FeCl<sub>3</sub>
- Test temperature: 22°C, 50°C (Recommended temperature in this test)
- Test time: 72h

ASTM G48 Method C

- Test solution: 6%FeCl<sub>3</sub> + 1%HCl
- Test time: 72h

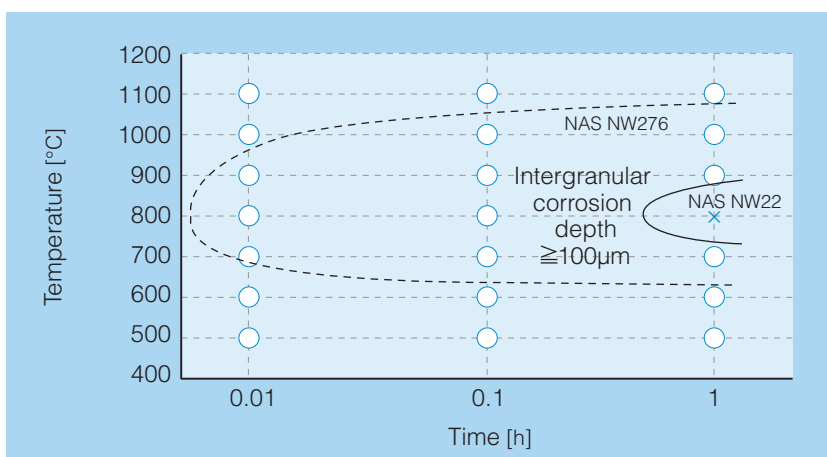
Crevice Corrosion Resistance

Alloy	ASTM G48 Method D
	Critical crevice corrosion temperature CCT (°C)
NAS 185N	40
NAS 254N	45
NAS NW22	>103

Test conditions ASTM G48 Method D

- Test solution: 6%FeCl<sub>3</sub> + 1%HCl
- Test time: 72h

Intergranular Corrosion Resistance



Test conditions: ASTM G28 Method A  
 Test time 24h,  
 boiling 50%H<sub>2</sub>SO<sub>4</sub> - Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> solution

### Stress Corrosion Cracking Resistance

Alloy	MgCl <sub>2</sub> concentration (boiling point (°C) are in brackets)							
	45% (155°C)	42% (143°C)	40% (138°C)	38% (134°C)	35% (126°C)	30% (115°C)	25% (110°C)	20% (108°C)
NAS 185N	x	x	x	x	○	○	○	○
NAS 254N	x	x	x	○	○	○	○	○
NAS NW22	○	○	○	○	○	○	○	○

Test conditions

- Immersion in boiling MgCl<sub>2</sub> solution
- Test time: 300h
- U-bend test specimen is used.

○: No stress corrosion cracking  
x: Stress corrosion cracking

### Acid Resistance

Alloy	Corrosion rate in sulfuric acid at 80°C (mm/y)					
	5%	10%	20%	40%	60%	80%
NAS 185N	0.02	0.04	1.32	2.89	3.20	4.78
NAS 254N	0.02	0.05	1.02	2.11	2.16	7.76
NAS NW22	0.01	0.02	0.02	0.04	0.47	0.34

Test time: 24h

Alloy	Corrosion rate in hydrochloric acid at 80°C (mm/y)			
	0.1%	1%	2%	3%
NAS 185N	0.01	0.02	4.20	7.21
NAS 254N	0.01	0.02	0.01	9.14
NAS NW22	0.02	0.03	0.02	0.04

Test time: 24h

(Reference)

Nippon Yakin	JIS	UNS No.	Chemical composition
NAS 185N	SUS 312L	S31254	20Cr-18Ni-6Mo-0.8Cu-0.2N
NAS 254N	SUS 836L	S32053	23Cr-25Ni-5.5Mo-0.2N
NAS NW22	NW 6022	N06022	57Ni-21Cr-14Mo-3W-4Fe

### Workability

Because the high-temperature strength of NAS NW22 is extremely higher than that of Type 304, care is required when hot working. The cold workability of NAS NW22 is basically the same as that of standard austenitic stainless steels such as Type 304, Type 316, etc. However, the fact that this is a high strength material must be considered in cold working.

### Weldability

In welding, it is possible to apply ordinary welding methods in the same manner as with stainless steels. Matching composition welding consumables should be used. Post-weld heat treatment is not required.

### Heat Treatment

Solution annealing of NAS NW22 is normally performed at the temperature range from 1150 to 1170°C followed by being quenched in water or rapidly cooled by other means.

### Pickling

A mixture of nitric acid and fluoric acid is used in pickling. However, because descaling is somewhat difficult in comparison with Type 304, alkali immersion before acid pickling, and if possible, shot blasting are extremely effective.

### Applications

Pharmaceutical plants, semiconductor manufacturing equipment, various types of chemical plants, flue gas desulfurization plants

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