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

[wt %]

	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/cm³]		8.70
Specific heat	[J/kg · K]		440
Electrical resistivity	[μΩ · cm]		114.0
Thermal conductivity	[W/m · K]		10.6
Thermal diffusivity	[m²/s]		2.8×10^{-6}
Average coefficient of thermal expansion	[10^{-6}/°C]	20~100°C	12.4
		20~200°C	12.4
		20~300°C	12.6
		20~400°C	13.1
		20~500°C	13.7
Young's modulus	[MPa]		20.4×10^4
Modulus of rigidity	[MPa]		78.8×10^4
Magnetism			None
Melting range	[°C]		1325~1372

Acid Resistance

Test condition: Test time 24h

Test solution	Temperature (°C)	Concentration (%)	Corrosion rate [g/m² · hr]				
			NAS NW22	NAS NW276	NAS 254N*	NAS 329J3L*	Type 316L
H_2SO_4	80	5	0.01	0.02	0.02	0.00	1.10
		10	0.02	0.03	0.02	0.14	2.92
		20	0.02	0.04	1.16	3.33	20.1
		40	0.04	0.06	1.78	250.5	291.3
		60	0.47	0.08	1.86	263.1	72.0
		80	0.34	0.03	2.82	90.4	11.1
	Boiling	5	0.14	0.10	1.43	0.61	5.45
		10	0.25	0.16	2.49	3.30	18.0
		20	0.72	0.33	6.18	76.2	108.7
		40	3.24	1.44	21.0	271.7	297.8
HCl	80	0.1	0.00	0.00	0.00	0.00	0.01
		1.0	0.00	0.02	0.00	0.01	2.45
		2.0	0.01	0.03	3.15	19.0	6.66
		3.0	0.03	0.33	12.8	51.5	13.6
	Boiling	0.1	0.00	0.00	0.00	0.00	0.01
		1.0	0.13	0.23	0.13	4.82	6.32
		2.0	1.32	0.91	27.8	56.7	33.6
		3.0	3.63	1.64	54.2	145.2	69.1

Converted to mm/y from unit corrosion rate, g/m² · h
mm/y = g/m² · h × 8.76/d (d: density)
[d] NAS NW22: 8.70g/cm³, NAS NW276: 8.90g/cm³, NAS 254N: 8.06g/cm³, NAS 329J3L: 7.80g/cm³, Type 316L: 7.98g/cm³

* NAS 254N: 23Cr-25Ni-5.5Mo-0.2N (austenitic super stainless steel)
* NAS 329J3L: 22.5Cr-5.3Ni-3.2Mo-0.16N (duplex stainless steel)

Stress Corrosion Cracking Resistance

Test conditions: Immersion in boiling $MgCl_2$ solution, test time 300h, U-bend test piece is used

Alloy	$MgCl_2$ concentration (boiling point (°C) are in brackets)					
	20% (108)	25% (110)	30% (115)	35% (126)	38% (134)	42% (142)
NAS NW22	○	○	○	○	○	○
NAS NW276	○	○	○	○	○	○
NAS 254N	○	○	○	○	○	×
NAS 329J3L	○	○	×	×	×	×
Type 316L	○	×	×	×	×	×

○: No stress corrosion cracking ×: Stress corrosion cracking occurred

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^t	367	744	73	84
	Cold-rolled sheet 8mm^t	365	752	69	84
	Cold-rolled sheet 3mm^t	383	782	57	86

In all cases, solution treated materials

Corrosion Resistance

Pitting Corrosion Resistance

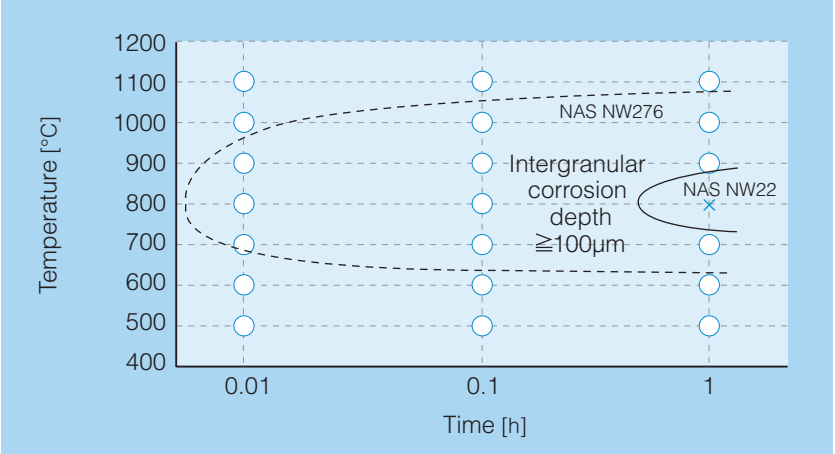
Alloy	Critical pitting corrosion temperature [CPT]	
	6%$FeCl_3$ + 1%HCl solution (ASTM G48 Method C)	Green death solution
NAS NW22	>120°C	>120°C
NAS NW276	>120°C	>120°C
NAS 254N	80°C	80°C
NAS 329J3L	50°C	45°C
Type 316L	10°C	25°C

Crevice Corrosion Resistance

Alloy	Critical crevice corrosion temperature [CCT]	
	6%$FeCl_3$ + 1%HCl solution (ASTM G48 Method D)	Green death solution
NAS NW22	>100°C	110°C
NAS NW276	100°C	110°C
NAS 254N	40°C	45°C
NAS 329J3L	25°C	30°C
Type 316L	<0°C	<0°C

Test conditions ①ASTM G48 Method C: Test time 72h
②ASTM G48 Method D: Test time 72h, crevice formation by multicrevice
③Immersion in green death solution: Test time 24h, test solution 7%H_2SO_4 + 3%HCl + 1%$FeCl_3$ + 1%$CuCl_2$;
multicrevice is used in the crevice corrosion test

Intergranular Corrosion Resistance



Test conditions: ASTM G28 Method A
Test time 24h,
boiling 50%H_2SO_4 - $Fe_2(SO_4)_3$ solution

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

The solution treatment temperature is 1150~1170°C. Quenching is necessary after heat treatment.

Applications

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

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