

# Hastelloy® C-22

Material no. 2.4602 · NiCr21Mo14W · Ni-Cr-Mo-W alloy for aggressive chemical applications

**Material group:** Nickel-chromium-molybdenum-tungsten alloy, universal corrosion resistance

**Material no. (EN):** 2.4602

**EN designation:** NiCr21Mo14W

**UNS / ASME:** UNS N06022

**Trade names:** Hastelloy® C-22, Nicrofer® 5621 hMoW, Alloy 22

**ASTM / ASME equivalent:** Pipes: B622 (seamless) / B626 (welded) · Fittings: B366 WPHC22 · Flanges: B564

**Service temperature:** -196 °C to +400 °C (continuous); short term to 675 °C

**Standards (pipes):** EN 10216-5 · ASTM B622 / B626 · VdTÜV 479

**Standards (fittings):** EN 10253-4 · ASTM B366 WPHC22

**Forms (Nirotec):** Elbows · tees · reducers · caps · flanges · custom parts

## 1 Material Equivalents & Comparable Grades

### National equivalents

Standard / region	Designation	Material no. / Grade	Remark
EN	NiCr21Mo14W	2.4602	Current European designation
UNS	Alloy 22	N06022	ASTM/ASME designation
DIN (old)	NiCr21Mo14W	2.4602	Identical, unchanged
ASTM/ASME	A/SA B622 / B626	UNS N06022	Seamless / welded pipes
ASTM/ASME	A/SA B366 WPHC22	UNS N06022	Buttweld fittings
ASTM/ASME	A/SA B564	UNS N06022	Forgings, flanges
Trade names	Hastelloy® C-22, Nicrofer® 5621 hMoW	–	Common trade names

### Alternative materials

Material	Material no.	Reference / use	Note
Hastelloy C-276 / 2.4819	2.4819	Lower Cr, similar application range	More universal corrosion
Alloy 59 / 2.4605	2.4605	Highest resistance to reducing acids	FGD, acid scrubbers
Inconel 625 / 2.4856	2.4856	Lower Mo, higher strength	Structural applications

Material	Material no.	Reference / use	Note
Hastelloy C-4 / 2.4610	2.4610	Simplified composition	General corrosion

## 2 Chemical Composition

Composition in mass percent (%). Standard: ASTM B575 / VdTÜV 479. Hastelloy C-22 is an evolved variant of C-276 with higher Cr content (21 % vs 16 %) – combining excellent resistance to oxidising AND reducing media.

Element	Symbol	Min. (heat)	Max. (heat)	Max. (product)	Function / remark
Nickel	Ni	Rest	Rest	Rest	Matrix (~56 %)
Chromium	Cr	20.0	22.5	22.5	Oxidation / pitting resistance
Molybdenum	Mo	12.5	14.5	14.5	Pitting / crevice corrosion resistance
Tungsten	W	2.5	3.5	3.5	Crevice corrosion resistance
Iron	Fe	2.0	6.0	6.0	Structural element
Cobalt	Co	–	2.5	2.5	Limit
Manganese	Mn	–	0.50	0.50	Limit
Vanadium	V	–	0.35	0.35	Limit
Carbon	C	–	0.015	0.015	Low-C limit (avoids precipitation)
Silicon	Si	–	0.08	0.08	Low-Si limit
Phosphorus	P	–	0.02	0.02	Impurity limit
Sulfur	S	–	0.02	0.02	Impurity limit

## 3 Mechanical Properties

### Solution annealed – minimum requirements (ASTM B622 / VdTÜV 479)

Property	Symbol	Unit	Minimum value	Remark
Yield strength 0.2 %	Rp0.2	MPa	≥ 310	Solution annealed
Tensile strength	Rm	MPa	≥ 690	Solution annealed
Elongation at fracture	A	%	≥ 45	Longitudinal specimens
Impact energy (20 °C)	KV	J	≥ 80	Mean value
Hardness	HRB	–	≤ 100	Reference value

### Hot yield strength Rp0.2 in MPa (typical values per standard)

Temperature	100 °C	200 °C	300 °C	400 °C	500 °C	600 °C
Rp0.2 (MPa)	270	240	225	210	195	185

## 4 Physical Properties

Property	Symbol	20 °C	200 °C	400 °C	600 °C	Unit
Density	$\rho$	8.69	8.62	8.51	8.40	g/cm <sup>3</sup>
Modulus of elasticity	E	206	197	183	168	GPa
Thermal conductivity	$\lambda$	10.1	12.3	15.1	17.8	W/(m·K)
Coeff. thermal expansion	$\alpha$	12.4	12.8	13.4	14.0	10 <sup>-6</sup> /K
Specific heat capacity	cp	414	438	470	500	J/(kg·K)

## 5 Corrosion Resistance

Medium / environment	Remark	Resistance
Oxidising acids (HNO <sub>3</sub> , mixed)	Outstanding due to high Cr content	++
Hydrochloric acid (HCl, all conc.)	Very good resistance	++
Sulphuric acid (H <sub>2</sub> SO <sub>4</sub> )	Resistant across full concentration range	++
Chlorides / seawater	Outstanding (PREN > 70)	++
Sour gas (H <sub>2</sub> S)	NACE MR0175 qualified	++
Mixed oxidising + reducing media	Universal resistance – key strength	++
Stress-corrosion cracking	Highly resistant	++
Phosphoric acid (H <sub>3</sub> PO <sub>4</sub> )	Very good resistance	++
High-temperature oxidation > 600 °C	Limited resistance	o
Hydrofluoric acid (HF)	Not recommended	-

++ excellent resistance	+ good resistance	o limited resistance	- not resistant
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Hastelloy C-22 is the universal chemical material – resistant to both oxidising and reducing media. Main advantage over C-276: better resistance in oxidising chlorides.

## 6 Typical Applications

Industry / plant	Typical application	Operating condition
Chemical industry	Reactors, acid piping, columns	Mixed oxidising and reducing acids
Flue-gas desulphurisation (FGD)	Scrubbers, absorbers	Acidic flue gases with chlorides
Pharma & food industry	Ultra-pure systems, piping	Demanding cleaning media
Pulp & paper	ClO <sub>2</sub> bleaching plants	Chlorine-bearing aggressive media
Offshore / marine	Subsea components, umbilicals	Seawater, sour service
Waste incineration	Boiler and scrubber components	Acidic chloride-loaded combustion gases

## 7 Forms Available at Nirotec

Component	Standard (EN)	Standard (ASME/ASTM)	Remark
Elbows	EN 10253-4	ASME B16.9 · B366 WPHC22	LR/SR, custom angles on request
Tees	EN 10253-4	ASME B16.9 · B366 WPHC22	Equal and reducing branch
Reducers	EN 10253-4	ASME B16.9 · B366 WPHC22	Concentric and eccentric
Caps	EN 10253-4	ASME B16.9 · B366 WPHC22	Hemispherical caps
Weld neck flanges	EN 1092-1 type 11	ASME B16.5 · B564	PN 10 – PN 400 / Class 150 – 2500
Custom parts	Per drawing	Per drawing	Custom geometries on request

## 8 Standards, Approvals & Codes

Standard / code	Title / application
EN 10216-5	Seamless tubes for pressure purposes – stainless and nickel-base alloys
EN 10253-4	Butt-welding fittings – austenitic and nickel-base alloys
EN 1092-1	Flanges and their joints
VdTÜV 479	NiCr21Mo14W (2.4602) – material data sheet
ASTM B622 / B626	Seamless / welded pipes – UNS N06022
ASTM B366	Factory-made wrought nickel-alloy fittings (WPHC22)

Standard / code	Title / application
ASTM B564	Nickel-alloy forgings
NACE MR0175 / ISO 15156	Materials for H <sub>2</sub> S-containing environments
PED 2014/68/EU	Pressure Equipment Directive
ASME B31.3	Process piping

## 9 Processing Notes

### Weldability

Parameter	Specification / recommendation	Remark
Preheat	Not required	Room-temperature welding
Post-weld heat treatment	Generally not required	PWHT only in special cases
Filler metal	ERNiCrMo-10 (AWS A5.14)	Matching nickel-base filler
Welding processes	GTAW (TIG), GMAW, SMAW	All standard processes suitable
Interpass temperature	≤ 150 °C	Prevents phase precipitation

- Delivery condition: solution annealed – maximum corrosion resistance
- Cleanliness: free from grinding marks, oil and contaminants before welding
- Identification per ASTM B622: heat no., 2.4602 / UNS N06022, standard, dimensions
- Caution for sustained 650–1000 °C exposure – possible phase precipitation
- Excellent suitability for sour service per NACE MR0175

## 10 Inquiry & Contact

For a project-specific inquiry we ideally require:

- Standard and type (e.g. ASTM B622 / B366 WPHC22 LR 90°)
- Dimensions: DN / NPS, wall thickness or schedule
- Quantity and required delivery date
- Required documentation (EN 10204 type 3.1 / 3.2, NDT, external inspection)
- Project-specific specification (NACE MR0175, FDA, etc.)

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