

# 904L / 1.4539

Material no. 1.4539 · X1NiCrMoCu25-20-5 · Highly alloyed austenitic stainless steel

**Material group:** Highly alloyed austenitic stainless steel with Mo and Cu, PREN ≈ 34

**Material no. (EN):** 1.4539

**EN designation:** X1NiCrMoCu25-20-5

**UNS / AISI:** UNS N08904 · 904L

**Trade names:** 904L, Uranus B6®, Sandvik 2RK65®, Nicrofer® 3033

**ASTM / ASME equivalent:** Pipes: A312 TP904L · Fittings: A403 WP904L · Flanges: A182 F904L

**Service temperature:** –196 °C to +400 °C (continuous service)

**Standards (pipes):** EN 10216-5 · ASTM A312 · VdTÜV 421

**Standards (fittings):** EN 10253-4 · ASTM A403 WP904L · ASME B16.9

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

## 1 Material Equivalents & Comparable Grades

### National equivalents

Standard / region	Designation	Material no. / Grade	Remark
EN	X1NiCrMoCu25-20-5	1.4539	Current European designation
UNS	904L	N08904	ASTM/ASME designation
AISI	904L	–	US designation (despite Mo content)
DIN (old)	X1NiCrMoCu25-20-5	1.4539	Identical, unchanged
ASTM/ASME	A/SA 312 TP904L	UNS N08904	Seamless / welded pipes
ASTM/ASME	A/SA 403 WP904L	UNS N08904	Buttweld fittings
ASTM/ASME	A/SA 182 F904L	UNS N08904	Forgings, flanges
Trade names	904L, Uranus B6®, Sandvik 2RK65®	–	Common trade names

### Alternative materials

Material	Material no.	Reference / use	Note
316L / 1.4404	1.4404	Lower alloyed, significantly less expensive	Moderate requirements
254 SMO / 1.4547	1.4547	Higher Mo content, higher PREN	More heavily chloride-bearing media

Material	Material no.	Reference / use	Note
Incoloy 825 / 2.4858	2.4858	Nickel-base, similar profile	Premium alternative, higher H <sub>2</sub> SO <sub>4</sub> resistance
1.4462 / Duplex 2205	1.4462	Higher strength	When strength more important than processability

## 2 Chemical Composition

Composition in mass percent (%). Standard: ASTM A312 / VdTÜV 421. 904L is a highly alloyed austenitic stainless steel with ~25 % Ni, ~20 % Cr, ~4.5 % Mo and 1.5 % Cu. Originally developed for sulphuric-acid applications – the Cu content is the key differentiator over ordinary austenitic stainless steels.

Element	Symbol	Min. (heat)	Max. (heat)	Max. (product)	Function / remark
Carbon	C	–	0.020	0.020	Low-C limit, no sensitisation
Silicon	Si	–	0.70	0.70	Limit
Manganese	Mn	–	2.00	2.00	Limit
Phosphorus	P	–	0.030	0.030	Impurity limit
Sulfur	S	–	0.010	0.010	Impurity limit
Chromium	Cr	19.0	21.0	21.0	Corrosion resistance
Nickel	Ni	24.0	26.0	26.0	Austenite stabilisation, SCC resistance
Molybdenum	Mo	4.0	5.0	5.0	Pitting / acid resistance
Copper	Cu	1.2	2.0	2.0	Sulphuric acid resistance
Nitrogen	N	–	0.15	0.15	Limit

## 3 Mechanical Properties

### Solution annealed – minimum requirements (ASTM A312)

904L is solution annealed at 1090–1175 °C and water quenched.

Property	Symbol	Unit	Minimum value	Remark
Yield strength 0.2 %	Rp0.2	MPa	≥ 220	Solution annealed
Tensile strength	Rm	MPa	≥ 490	–
Elongation at fracture	A	%	≥ 35	Longitudinal specimens
Impact energy (–196 °C)	KV	J	≥ 100	Excellent low-temperature toughness
Hardness	HB	–	≤ 220	Reference value
PREN	–	–	≥ 34	Pitting Resistance Equivalent

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

Temperature	100 °C	200 °C	300 °C	400 °C
Rp0.2 (MPa)	170	150	135	125

## 4 Physical Properties

Property	Symbol	20 °C	200 °C	400 °C	Unit
Density	$\rho$	8.0	7.93	7.83	g/cm <sup>3</sup>
Modulus of elasticity	E	195	186	172	GPa
Thermal conductivity	$\lambda$	12.5	15.0	18.0	W/(m·K)
Coeff. thermal expansion	$\alpha$	15.8	16.3	17.0	10 <sup>-6</sup> /K
Specific heat capacity	cp	450	490	525	J/(kg·K)

## 5 Corrosion Resistance

Medium / environment	Remark	Resistance
Sulphuric acid (H <sub>2</sub> SO <sub>4</sub> )	Very good resistance up to ~75 % concentration	++
Phosphoric acid (H <sub>3</sub> PO <sub>4</sub> )	Good resistance over wide concentration range	++
Stress-corrosion cracking (Cl <sup>-</sup> )	Highly resistant due to high Ni content	++
Nitric acid (HNO <sub>3</sub> )	Good resistance	++
Mixed acids (pickling baths)	Good resistance	+
Sour gas (H <sub>2</sub> S)	Limited – NACE MR0175 special approval required	+
Chloride-bearing media (medium)	Resistant up to ~1000 ppm Cl <sup>-</sup>	+
Seawater (flowing)	Conditional – PREN 34 not always sufficient	o
Hydrochloric acid (HCl) dilute	Limited resistance	o
Hydrofluoric acid (HF)	Not recommended	-

++ excellent resistance
+ good resistance
o limited resistance
- not resistant

904L is the classic acid-service material – originally developed for sulphuric acid, offering good corrosion resistance with better processability than nickel-base alloys.

## 6 Typical Applications

Industry / plant	Typical application	Operating condition
Sulphuric acid plants	Reactors, evaporators, piping	H <sub>2</sub> SO <sub>4</sub> medium to high concentration
Phosphoric acid production	Tanks, evaporators	Hot H <sub>3</sub> PO <sub>4</sub>
Pickling lines	Pickling tanks, piping	Mixed acids (sulphuric + nitric)
Chemical process engineering	Reactors, heat exchangers, vessels	Corrosive process media
Pharmaceutical	Ultra-pure systems, piping	FDA-compliant applications
Seawater (limited)	Cooling water, heat exchangers	Limited – 254 SMO better suited

## 7 Forms Available at Nirotec

Component	Standard (EN)	Standard (ASME/ASTM)	Remark
Elbows	EN 10253-4	ASME B16.9 · A403 WP904L	LR/SR, 90°/45°, custom angles
Tees	EN 10253-4	ASME B16.9 · A403 WP904L	Equal and reducing branch
Reducers	EN 10253-4	ASME B16.9 · A403 WP904L	Concentric and eccentric
Caps	EN 10253-4	ASME B16.9 · A403 WP904L	Hemispherical caps
Weld neck flanges	EN 1092-1 Type 11	ASME B16.5 · A182 F904L	PN 10 – PN 400 / Class 150 – 2500
Custom parts	Per drawing	Per drawing	Special components on request

## 8 Standards, Approvals & Codes

Standard / code	Title / application
EN 10216-5	Seamless tubes for pressure purposes – stainless steels
EN 10253-4	Butt-welding fittings – austenitic stainless steels
EN 1092-1	Flanges and their joints
VdTÜV 421	X1NiCrMoCu25-20-5 (1.4539) – material data sheet
ASTM A312	Seamless / welded pipes – UNS N08904
ASTM A403	Buttweld fittings – austenitic stainless (WP904L)
ASTM A182 F904L	Forgings, flanges – UNS N08904
PED 2014/68/EU	Pressure Equipment Directive

Standard / code	Title / application
ASME B31.3	Process piping

## 9 Processing Notes

### Weldability

Parameter	Specification / recommendation	Remark
Preheat	Not required	Avoids hot cracking
Post-weld heat treatment	Generally not required	Solution anneal only for sensitised material
Filler metal	ER385 (AWS A5.9) / 904L filler	Matching filler, low carbon
Welding processes	GTAW, GMAW, plasma, SMAW	Low heat input recommended
Interpass temperature	≤ 150 °C	Standard for austenitic stainless

- Delivery condition: solution annealed (1090–1175 °C) + water quenched – essential for corrosion resistance
- Identification per ASTM A312: heat no., 1.4539 / N08904, standard, dimensions
- Fully austenitic structure – non-magnetic, slight magnetism after cold working
- For sustained 600–950 °C exposure:  $\sigma$ -phase precipitation possible – corrosion and embrittlement
- Corrosion protection of weld: root shielding gas (Ar) mandatory

## 10 Inquiry & Contact

For a project-specific inquiry we ideally require:

- Standard and type (e.g. ASTM A403 WP904L 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 (PMI, FDA, acid service etc.)

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