

Incoloy® 825

Material no. 2.4858 · NiCr21Mo · Nickel-iron-chromium-molybdenum-copper alloy

Material group: Nickel-iron-chromium alloy with Mo and Cu, corrosion resistant

Material no. (EN): 2.4858

EN designation: NiCr21Mo

UNS / ASME: UNS N08825

Trade names: Incoloy® 825, Nicrofer® 4221, Alloy 825

ASTM / ASME equivalent: Pipes: B423 (seamless) / B704 (welded) · Fittings: B366 WPNIC · Flanges: B564

Service temperature: -196 °C to +540 °C (continuous)

Standards (pipes): EN 10216-5 · ASTM B423 / B704 · VdTÜV 432

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

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

1 Material Equivalents & Comparable Grades

National equivalents

Standard / region	Designation	Material no. / Grade	Remark
EN	NiCr21Mo	2.4858	Current European designation
UNS	Alloy 825	N08825	ASTM/ASME designation
DIN (old)	NiCr21Mo	2.4858	Identical, unchanged
ASTM/ASME	A/SA B423 / B704	UNS N08825	Seamless / welded pipes
ASTM/ASME	A/SA B366 WPNIC	UNS N08825	Buttweld fittings
ASTM/ASME	A/SA B564	UNS N08825	Forgings, flanges
Trade names	Incoloy® 825, Nicrofer® 4221	–	Common trade names

Alternative materials

Material	Material no.	Reference / use	Note
Inconel 625 / 2.4856	2.4856	Higher corrosion and hot strength	Aggressive media, higher temp.
Hastelloy C-276 / 2.4819	2.4819	Better resistance to chlorides	Complex acids, sour service
904L / 1.4539	1.4539	Lower-cost alternative	Moderate requirements

Material	Material no.	Reference / use	Note
20Cb-3 / 2.4660	2.4660	Dedicated to sulphuric acid	Concentrated H ₂ SO ₄

2 Chemical Composition

Composition in mass percent (%). Standard: ASTM B423 / VdTÜV 432. Incoloy 825 is a Ni-Fe-Cr alloy with Mo, Cu and Ti stabilising against stress-corrosion cracking in chloride-bearing media and sulphuric acid.

Element	Symbol	Min. (heat)	Max. (heat)	Max. (product)	Function / remark
Nickel	Ni	38.0	46.0	46.0	Matrix
Chromium	Cr	19.5	23.5	23.5	Oxidation / general corrosion resistance
Iron	Fe	22.0	Rest	Rest	Balance (~30 %)
Molybdenum	Mo	2.5	3.5	3.5	Pitting and reducing-acid resistance
Copper	Cu	1.5	3.0	3.0	Sulphuric acid resistance
Titanium	Ti	0.6	1.2	1.2	Stabilises against intergranular corrosion
Carbon	C	–	0.05	0.05	Low-C limit
Manganese	Mn	–	1.0	1.0	Limit
Silicon	Si	–	0.5	0.5	Limit
Aluminium	Al	–	0.2	0.2	Limit
Phosphorus	P	–	0.03	0.03	Impurity limit
Sulfur	S	–	0.03	0.03	Impurity limit

3 Mechanical Properties

Solution annealed – minimum requirements (ASTM B423 / VdTÜV 432)

Property	Symbol	Unit	Minimum value	Remark
Yield strength 0.2 %	Rp0.2	MPa	≥ 241	Solution annealed
Tensile strength	Rm	MPa	≥ 586	Solution annealed
Elongation at fracture	A	%	≥ 30	Longitudinal specimens
Impact energy (20 °C)	KV	J	≥ 60	Mean value
Hardness	HRB	–	≤ 95	Reference value

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

Temperature	100 °C	200 °C	300 °C	400 °C	500 °C	540 °C
Rp0.2 (MPa)	220	200	185	172	162	155

4 Physical Properties

Property	Symbol	20 °C	200 °C	400 °C	540 °C	Unit
Density	ρ	8.14	8.06	7.96	7.90	g/cm ³
Modulus of elasticity	E	196	188	175	166	GPa
Thermal conductivity	λ	11.1	13.0	16.0	18.0	W/(m·K)
Coeff. thermal expansion	α	13.4	14.0	14.8	15.3	10 ⁻⁶ /K
Specific heat capacity	cp	440	470	510	535	J/(kg·K)

5 Corrosion Resistance

Medium / environment	Remark	Resistance
Sulphuric acid (H ₂ SO ₄)	Very good resistance due to Cu content	++
Phosphoric acid (H ₃ PO ₄)	Good up to high concentrations	++
Sour gas (H ₂ S)	NACE MR0175 qualified	++
Stress-corrosion cracking (Cl ⁻)	Highly resistant, Ti-stabilised	++
Nitric acid (HNO ₃) dilute	Good resistance	+
Hydrochloric acid (HCl) dilute	Resistant at low concentrations	+
Brine / seawater	Good, but more suitable materials available	+
High-temperature oxidation	Limited > 600 °C	o
Hydrofluoric acid (HF)	Not recommended	-
Concentrated reducing halogen acids	Not resistant	-

++ excellent resistance	+ good resistance	o limited resistance	- not resistant
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Incoloy 825 is the standard choice when sulphuric-acid resistance, sour-gas service and chloride SCC resistance are required simultaneously.

6 Typical Applications

Industry / plant	Typical application	Operating condition
Chemical industry	Sulphuric acid plants, pickling lines, reactors	H ₂ SO ₄ , mixed acids
Oil & gas (on/offshore)	Sour-gas piping, heat exchangers	Sour service (NACE MR0175)
Phosphoric acid production	Reactor and evaporator equipment	Hot H ₃ PO ₄
Nuclear fuel reprocessing	Piping and vessels	Concentrated acids
Environmental (FGD)	Flue-gas scrubbers, absorbers	Acidic, chloride-loaded gases
Food & pharmaceutical	Hygienic piping	Corrosive cleaning media

7 Forms Available at Nirotec

Component	Standard (EN)	Standard (ASME/ASTM)	Remark
Elbows	EN 10253-4	ASME B16.9 · B366 WPNIC	LR/SR, custom angles on request
Tees	EN 10253-4	ASME B16.9 · B366 WPNIC	Equal and reducing branch
Reducers	EN 10253-4	ASME B16.9 · B366 WPNIC	Concentric and eccentric
Caps	EN 10253-4	ASME B16.9 · B366 WPNIC	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 pipes 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 432	NiCr21Mo (2.4858) – material data sheet
ASTM B423 / B704	Seamless / welded pipes – UNS N08825
ASTM B366	Factory-made wrought nickel-alloy fittings (WPNIC)
ASTM B564	Nickel-alloy forgings
NACE MR0175 / ISO 15156	Materials for H ₂ S-containing environments (sour service)

Standard / code	Title / application
PED 2014/68/EU	Pressure Equipment Directive
ASME B31.1 / B31.3	Power / 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	ERNiFeCr-1 (AWS A5.14)	Matching nickel-base filler
Welding processes	GTAW (TIG), GMAW, SMAW	All standard processes suitable
Interpass temperature	≤ 150 °C	Avoids intergranular corrosion

- Delivery condition: solution annealed at 925–955 °C, water quenched
- Cleanliness: free from grinding marks, oil and contaminants before welding
- Identification per ASTM B423: heat no., 2.4858 / UNS N08825, standard, dimensions
- Well suited for sour service per NACE MR0175
- Caution at sustained 540–800 °C exposure: possible sensitisation

10 Inquiry & Contact

For a project-specific inquiry we ideally require:

- Standard and type (e.g. ASTM B423 / B366 WPNIC 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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