outokumpu
high performance stainless steel

Outokumpu Ultra Alloy 825 nickel alloy

Including long products

Outokumpu Ultra Alloy 825 (W.-Nr. 2.4858, UNS N08825, ISO NW8825) is a titanium stabilized austenitic nickel alloy with an addition of copper.

General properties

- Excellent resistance to stress corrosion cracking
- Very good resistance in oxidizing and reducing acids
- Moderate resistance to pitting and crevice corrosion
- Good mechanical properties also at elevated temperatures
- Reduced risk for sensitization when used in temperature ranges where this is a problem for stainless steels

Typical applications

- Components in sour gas service
- Offshore oil and gas piping systems
- Equipment in petroleum refineries
- Heating coils
- Heat exchangers
- Tanks
- Scrubbers
- Chemical processing equipment
- Nuclear industry equipment

Outokumpu Ultra Alloy 825 (UNS N08825) is listed in ISO 15156-3 (NACE MR0175), Materials for oil and gas production, and in ISO 17945 (NACE MR0103), Metallic materials resistant to sulphide stress cracking in corrosive petroleum refining environments.

Chemical composition

Table 1

Outokumpu name	International designation			Typical chemical composition, % by mass									
	W.-Nr.	UNS	ISO	C	Cr	Ni	Mo	Cu	Ti	Mn	Si	Al	Fe
Ultra Alloy 825	2.4858	N08825	NW8825/NiFe30Cr21Mo3	0.01	23.0	39.0	3.2	1.7	0.7	0.8	0.4	0.1	bal.

For welding applications (Wire Rod), the chemistry is slightly different since Nickel is 42%.

Chemical composition

The typical chemical composition of Outokumpu Ultra Alloy 825 is shown in Table 1.

Microstructure

Outokumpu Ultra Alloy 825 has an austenitic microstructure. The titanium stabilization together with the low carbon content reduce the risk to form chromium carbide precipitations when used at temperatures where e.g. stainless steels may be sensitive to this phenomenon. This makes the alloy less sensitive to intergranular corrosion.

Mechanical properties

Outokumpu Ultra Alloy 825 shows good mechanical properties from moderately high temperatures down to cryogenic temperatures. Outokumpu Ultra Alloy 825 shall not be used at temperatures above approximately 540 °C as ductility and impact strength become lowered due to changes in the microstructure. Outokumpu Ultra Alloy 825 is normally not used where creep rupture properties are design factors.

Typical mechanical properties and minimum values according to standards are given in Table 2.

Ultra Alloy 825 mechanical properties, room temperature

Table 2

	Product form	Yield strength $R_{p0.2}$ (MPa)	Tensile strength R_m (MPa)	Elongation $A^{1)}/A_{50}{}^{2)}/A_5{}^{3)}$ (%)
typical	cold rolled (3 mm)	305	625	44 [2)]
typical	hot rolled plate (20 mm)	270	610	35 [1)]
ISO 6208 (min. values)	cold rolled (C), hot rolled (H)	240	590	30 [1), 2)]
ASTM B424 (min. values)	cold rolled (C), hot rolled (H)	241	586	30 [2)]
typical	HRAP Wire rod (5.6–12.0 mm	min 200	550–650 MPa	min 50% [3)]

[1)] Initial length = 5.65 x $\sqrt{S^0}$ (A_5)
[2)] Initial length = 50 mm

Physical properties

The physical properties of Outokumpu Ultra Alloy 825 are shown in Table 3.

Ultra Alloy 825 physical properties

Table 3

Density [kg/dm³]	Modulus of elasticity [GPa]		Poisson's ratio	Coefficient of thermal expansion [10^{-6}/ °C]		Thermal conductivity [W/m °C]		Thermal capacity [J/kg °C]	Electrical resistivity [µΩm]	Magnetizable
RT	RT	400 °C	RT	20–100 °C	20–400 °C	RT	400 °C	RT	RT	RT
8.1	195	174	0.29	14.1	15.6	10.5	16.9	440	1.12	No [*)]

[*)] Relative Permeability at 15.9kA/m=1.005

Corrosion resistance

Uniform corrosion

Outokumpu Ultra Alloy 825 shows very good resistance in many acids, e.g. sulfuric acid (see Fig. 1 and 2), phosphoric acid, nitric acid as well as organic acids. Alloying with e.g. molybdenum and copper improves the corrosion resistance in reducing acids. Outokumpu Ultra Alloy 825 also shows good resistance in alkaline environments like sodium and potassium hydroxide solutions.

Pitting and crevice corrosion

The resistance to pitting and crevice corrosion is higher than for e.g. Supra 316L/4404 types of stainless steel, but does not reach the level of e.g. Ultra 254 SMO. Typical values in Table 4.

Stress corrosion cracking

The high nickel content of Outokumpu Ultra Alloy 825 contributes to the very high resistance to stress corrosion cracking, both chloride induced as well as in alkaline environments. This is illustrated by the fact that it is expected to pass over 24 hours without cracking when tested according to the very aggressive ASTM G36 (boiling 45% $MgCl_2$).

Outokumpu Ultra Alloy 825 also has excellent resistance to sulfide stress cracking. In accordance with ISO 15156-3 (NACE MR0175) solution annealed and cold worked Ultra Alloy 825 is acceptable for use for any component or equipment up to 232°C in sour environments, with no limits on chloride concentration and in situ pH, providing that the partial pressure of hydrogen sulfide (pH_2S) does not exceed 2 bar (30 psi). If the temperature does not exceed 132°C, the material is acceptable for use without restriction on partial pressure.

Intergranular corrosion

Outokumpu Ultra Alloy 825 is stabilized with titanium which in combination with the low carbon content improves the resistance to intergranular corrosion.

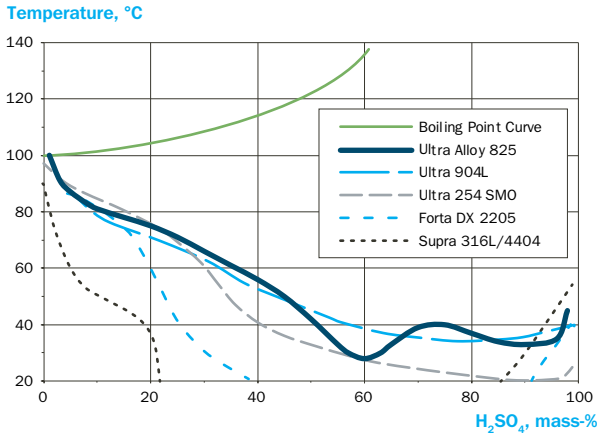

Fig. 1. Isocorrosion diagram in naturally aerated sulfuric acid of chemical purity, based on uniform corrosion tests with sample activation according to ISO 18069. The line represents a limit for corrosion resistance below which the corrosion rate is lower than 0.1 mm/year.

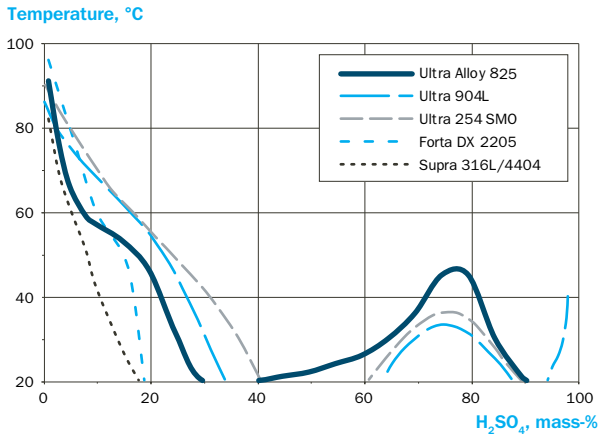

Fig. 2. Isocorrosion diagram in naturally aerated sulfuric acid of chemical purity with an addition of 200 ppm chlorides, based on uniform corrosion tests with sample activation according to ISO 18069. The line represents a limit for corrosion resistance below which the corrosion rate is lower than 0.1 mm/year.

Corrosion resistance

Table 4

Outokumpu designation	Critical Pitting Temperature, CPT [°C]		Critical Crevice Temperature, CCT [°C]
	ASTM G150 [1]	ASTM G48 E [2]	ASTM G48 F [2]
Ultra Alloy 825	58	25	5
Supra 316L/4404	20	20	<0
Forta DX 2205	52	40	20
Ultra 254 SMO	87	65	35
Ultra 904L	58	40	10

[1] Wet ground test surfaces, P320 grit.
[2] Dry ground test surfaces, P120 grit.

Fabrication

The fabricability of Outokumpu Ultra Alloy 825 is similar to other types of nickel alloys.

Formability

Outokumpu Ultra Alloy 825 has good ductility and can be formed using conventional methods.

Heat treatment

Post fabrication annealing is done at 950°C followed by rapid air cooling or water quenching.

Machining

Conventional techniques can be used also with Outokumpu Ultra Alloy 825. The material work hardens during machining.

Welding

Outokumpu Ultra Alloy 825 is readily weldable with conventional welding methods such as:

- Shielded metal arc welding (SMAW, MMA)
- Gas tungsten arc welding (GTAW, TIG)
- Gas metal arc welding (GMAW, MIG/MAG)
- Submerged Arc Welding (SAW)

Preheating before welding is not necessary.

Filler

Outokumpu Ultra Alloy 825 can be welded using matching filler. For e.g. SMAW, covered electrodes of the type 2.4621 or 2.4652 can be used.

Products

Outokumpu Ultra Alloy 825 is available as hot rolled plate, hot or cold rolled coil and sheet, and as hot rolled annealed and pickled (HRAP) wire rod.

Standards

Outokumpu Ultra Alloy 825 is approved for pressure vessels operating at temperatures up to 538°C, according to ASME Boiler & Pressure Vessel Code, Sections I, III, VIII, IX, Code cases 1936, N-188-1. Material data in Section IID. Some material standards are shown in Table 5.

Material standards

Table 5

Standard	Title/Subject
ISO 6208	Nickel and nickel alloy plate, sheet and strip
ISO 9722	Nickel and nickel alloys – Composition and forms of wrought products
ASTM B424	Standard specification for Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825, UNS N08221, and UNS N06845) plate, sheet and strip
ASTM B906	Standard specification for General Requirements for Flat-Rolled Nickel and Nickel Alloys plate, sheet and strip
ASME Boiler & Pressure Vessel Code, Sections I, IID, III, IX + Code cases 1936 and N-188-1	ASME boiler & pressure vessel design
ISO 15156 (NACE MR 0175)	Petroleum and natural gas industries – Materials for use in H_2S-containing environments in oil and gas production – Part: 3 Cracking-resistant CRA's (corrosion resistant alloys) and other alloys
ISO 17945 (NACE MR0103)	Petroleum, petrochemical and natural gas industries – Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments
VDTÜV 432	
DIN 17744 + 17750	Plate, sheet and strip

2027EN-US:1. February, 2020.

Working towards a world that lasts forever

We work with our customers and partners to create long lasting solutions for the tools of modern life and the world's most critical problems: clean energy, clean water, and efficient infrastructure. Because we believe in a world that lasts forever.

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