JACQUET

ALLOY 825 DATA SHEET

UNS N08825

GENERAL PROPERTIES //

////**Alloy 825** (UNS designation N08825) is a nickel-chromium alloy with additions of molybdenum and copper. It has excellent resistance to both reducing and oxidizing acids, to stress corrosion cracking, and to localized attacks such as pitting and crevice corrosion. **Alloy 825** is especially resistant to sulfuric and phosphoric acids. It offers outstanding performance in seawater.

APPLICATIONS //

//// CHEMICAL PROCESSING INDUSTRY

//// Heat Exchangers;

//// Evaporators;

//// Baffle Plates;

//// Pumps;

//// Piping;

//// Valves;

//// Expansion Bellows;

//// Tank Truck Trailers;

//// Scrubbers;

//// Condensers;

//// Tanks and Vessels;

//// Tank and Vessel Linings;

//// Mixers;

//// Agitators;

//// Heating Coils;

//// Racks.

//// PICKLING PROCESSES

//// Pickling;

//// Pickling Hooks;

//// Pickling Chains;

//// Piping;

//// Guide Rails;

//// Spray Pipes;

//// Racks;

//// Baskets.

//// ORE PRODUCTION

//// Hydrometallurgy;

//// Heat Exchangers.

//// POLLUTION CONTROL

//// Hopper Bottoms;

//// Trays in Electrostatic Precipitators;

//// Dampers;

//// Stack Gas Reheaters;

//// Waste Heat Recovery Exchangers;

//// Stack Liners;

//// Fan Housings;

//// Fans;

//// Mist Eliminators.

//// MARINE INDUSTRY

//// Heat Exchangers;

//// Piping;

//// Propeller Shafts;

//// Engine Exhaust Systems.

//// PULP AND PAPER

//// Wet Scrubber Linings.

//// MUNICIPAL WASTE INCINERATOR

//// Super Heater Tubing;

//// Boilers.

ALLOY 825

STANDARDS

Product form	Specifications				
	ASTM	**ASME**	**DIN**	**VdTÜV**	**BS**
Sheet and plate	**B**424	**SB**424	17750	432/1	3072
Strip	**B**424	**SB**424	17750	432/1	3073
Smls Pipe and Tubing	**B**423	**SB**423	17751	432/2	3074
Welded Pipe and Tubing	**B**163	**SB**163	–	–	–
Rod, Bar	**B**425	**SB**425	17752	432/3	3076
Forgings	–	–	17754	432/3	–

CHEMICAL COMPOSITION

C	Mn	S	Si	Cr	Ni	Fe	Mo	Cu	Ti	Al
0.05 **max**	1.00 **max**	0.03 **max**	0.50 **max**	19.5–23.5	38–46	22 **min**	2.5–3.5	1.5–3	0.6–1.2	0.2 **max**

MECHANICAL PROPERTIES

//// TYPICAL ROOM TEMPERATURE PROPERTIES

Form	Yield Strength 0.2% Offset		Ultimate Tensile Strength		Elongation
	ksi	**MPa**	**ksi**	**MPa**	**%**
Plate Annealed	49	338	96	662	45
Sheet Annealed	61	421	110	758	39
Rod and Bar Annealed	47	324	100	690	45
Tubing Cold Drawn	129	889	145	1000	15
Tubing Annealed	64	441	112	772	36

PHYSICAL PROPERTIES

Density	Magnetic Permeability	Specific Heat	Specific Gravity	Melting Range
0.294 **lb/in³**	200 **oersted** 1.005	0.105 **Btu/lb-°F**	8.13	2500–2550 **°F**
8.14 **g/cm³**		440 **J/kg-°K**		1370–1400 **°C**

//// ELEVATED TEMPERATURE PHYSICAL PROPERTIES

Temperature		Modulus of Elasticity		Thermal Conductivity		Electric Resistivity	
°F	°C	10^3 ksi	kN/mm²	Btu-in/ft²-hr-°F	W/m-°K	Ω circ mil/ft	μ Ω cm
32	0	–	–	73	10.5	677	112
68	20	28.3	195	75	10.8	678	112
200	93	27.4	–	85	–	687	–
212	100	–	190	–	12.4	–	114
392	200	–	185	–	14.1	–	118
400	204	26.8	–	98	–	710	–
572	300	–	179	–	15.6	–	120
600	316	25.8	–	110	–	728	–
762	400	–	174	–	16.9	–	124
800	427	25	–	120	–	751	–
932	500	–	168	–	18.3	–	126
1 000	538	23.8	–	131	–	761	–
1 112	600	–	161	–	19.6	–	126
1 200	649	22.7	–	142	–	762	–
1 292	700	–	154	–	21	–	127
1 400	760	21.2	–	155	–	765	–
1 472	800	–	142	–	23.2	–	128
1 600	871	19.4	–	172	–	775	–
1 652	900	–	130	–	25.7	–	129
1 800	982	17.3	–	192	–	782	–
1 832	1 000	–	119	–	28.1	–	130

IMPACT RESISTANCE //

Temperature		Orientation	Impact Energy	
°F	°C		ft.lbs	Joules
Room	**Room**	**Longitudinal**	79	107
Room	**Room**	**Transversal**	83	113
−110	−43	**Longitudinal**	78	106
−110	−43	**Transversal**	78.5	106
−320	−196	**Longitudinal**	67	91
−320	−196	**Transversal**	71.5	97
−423	−253	**Longitudinal**	68	92
−423	−253	**Transversal**	68	92

CORROSION RESISTANCE //

//// **Alloy 825** exhibits outstanding performance in both acids and alkalis in oxidizing as well as reducing environments. The high nickel content gives the alloy exceptional resistance to general corrosion, pitting, crevice corrosion, intergranular corrosion as well as stress corrosion cracking.

//// ELEVATED TEMPERATURE PHYSICAL PROPERTIES

Test Environment		Temperature		Length of Test	Corrosion Rate	
Name	Test conditions	°F	°C	Days	mpy	mm/y
Sulfuric Acid	40 % Sulfuric Acid	122	50	7	0.5	0.013
Sulfuric Acid	40 % Sulfuric Acid	212	100	7	14	0.36
Sulfuric Acid	60 % Sulfuric Acid	122	50	7	4	0.1
Sulfuric Acid	60 % Sulfuric Acid	212	100	7	20	0.51
Sulfuric Acid	80 % Sulfuric Acid	122	50	7	5	0.13
Sulfuric Acid	80 % H_2SO_4	212	100	7	20	0.51
Sulfuric Acid	Aqueous solution containing 0.05 % Sulfuric Acid	210	99	45	2	0.051
Sulfuric Acid	12 % Sulfuric Acid pickling solution containing copper sulfate up to 11.2 %. Immersed inside pickling tank.	180	82	26	0.2	0.005
Sulfuric Acid	50 % Sulfuric Acid, 22 % Nitric Acid & 19 % Water	150	66	6	0.5	0.013
Sulfuric Acid	50 % Sulfuric Acid, 22 % Nitric Acid & 19 % Water	182	83	5	4.3	0.109
Phosphoric Acid	45 % Phosphoric Acid	145–155	63–68	30	0.6	0.015
Phosphoric Acid	75 % Phosphoric Acid	172	78	30	0.2	0.005
Phosphoric Acid	75 % Phosphoric Acid	221	105	30	1.3	0.033
Phosphoric Acid	75 % Phosphoric Acid	240–260	116–127	30	3.9	0.009
Phosphoric Acid	20 % H_3PO_4, 2 % H_2SO_4, 1 % HF, 40 % H_2O plus $CaSO_4$	170–200	77–93	117	0.7	0.018
Phosphoric Acid	75–80 % H_3PO_4, 1 % H_2SO_4 with some HF. Violent Agitation	250–315	121–157	8	120	3.05
Nitric Acid	White fuming Nitric Acid	room	room	30	0.5	0.013
Nitric Acid	White fuming Nitric Acid	160	71	7	43	1.09
Nitric Acid	Inhibited white fuming Nitric Acid	room	room	30	0.2	0.005
Nitric Acid	Inhibited white fuming Nitric Acid	160	71	7	6.7	0.17
Nitric Acid	Inhibited red fuming Nitric Acid	room	room	30	0.6	0.015
Nitric Acid	Inhibited red fuming Nitric Acid	160	71	7	6.4	0.163
Hydrochloric Acid	5 % Hydrochloric Acid	room	room	–	4.9	0.124
Hydrochloric Acid	5 % Hydrochloric Acid	104	40	–	17.8	0.124
Hydrochloric Acid	5 % Hydrochloric Acid	150	66	–	79	2.007
Hydrochloric Acid	10 % Hydrochloric Acid	room	room	–	7.2	0.183
Hydrochloric Acid	10 % Hydrochloric Acid	104	40	–	18.6	0.472
Hydrochloric Acid	10 % Hydrochloric Acid	150	66	–	102	2.591
Hydrochloric Acid	20 % Hydrochloric Acid	room	room	–	7.3	0.185
Hydrochloric Acid	20 % Hydrochloric Acid	104	40	–	17.2	0.437
Hydrochloric Acid	20 % Hydrochloric Acid	150	66	–	60	1.524
Hydrochloric Acid	Concentrated Hydrochloric Acid	104	40	–	480	12.2
Hydrochloric Acid	Concentrated Hydrochloric Acid	150	66	–	1130	28.7
Acetic Acid	10 % Acetic Acid	boiling	boiling	5	<0.1	<0.003
Formic	10 % Formic Acid	boiling	boiling	5	2.5	0.064
Lactic	10 % Lactic Acid	boiling	boiling	5	0.3	0.008
Maleic	10 % Maleic Acid	boiling	boiling	5	0.1	0.003
Phtalic	10 % Phtalicic Acid	boiling	boiling	5	<0.1	<0.003
Oxalic	10 % Oxalic Acid	boiling	boiling	5	20	0.508
Organic Acid Mixture	99 % Acetic Acid, <0.1 % water	225	107	40	0.2	0.005
Organic Acid Mixture	96.5–98 % acetic acid, 1.5 % formic acid, 1–1.5 % water	225	107	262	6	0.152
Organic Acid Mixture	91.5 % acetic acid, 1.5–3 % formic acid, 0.5 % potassium permanganate, balance water	230–290	110–143	55	1.5	0.038
Organic Acid Mixture	40 % acetic acid, 6 % propionic acid, 20 % butane, 5 % pentane, 8 % ethyl acetate, 5 % methyl ethyl ketone, plus other esters and ketones	345	174	217	2	0.051

FORMABILITY

//// FORMING

//// **Alloy 825** has good ductility and may be readily formed by all conventional methods. Because the alloy is stronger than regular steel, it requires more powerful equipment to accomplish forming. Heavy-duty lubricants should be used during cold forming. It is essential to thoroughly clean all traces of lubricants after forming as embrittlement of the alloy may occur at high temperatures as a result

//// HEAT TREATMENT

//// Annealing is done at 1 750 °F (954 °C) with rapid air cool.

//// HOT WORKING

//// Hot working may be done but should be accomplished at temperatures under 1 700 °F (927 °C) to maintain optimum corrosion resistance of the alloy.

//// COLD WORKING

//// Cold forming may be done using standard tooling although lain carbon tool steels are not recommended as they tend to produce galling. Soft die materials (bronze, zinc alloys, etc.) minimize galling and produce good finishes, but die life is somewhat short. For long production runs, the alloy tool steels, (D-2, D-3) and high-speed steels (T-1, M-2, M-10) give good results, especially if hard chromium plated to reduce galling. Tooling should be such as to allow for liberal clearances and radii. Heavy duty lubricants should be used to minimize galling in all forming operations. Bending of sheet or plate through 180° is generally limited to a bend radius of 1 T for material up to .1 250" thick (3.175 mm) and 2 T for material thicker than .1 250" (3.175 mm).

//// HARDENING

//// Alloy 825 is hardened by cold work only.

//// WELDING

//// The commonly used welding methods work well with **Alloy 825**. Matching alloy filler metal should be used. If matching alloy is not available, then the nearest alloy richer in the essential chemistry, (Ni, Co, Cr, and Mo) should be used. All weld beads should be slightly convex.

//// It is not necessary to preheat. Surfaces to be welded must be clean from oil, paint or crayon markings and any residual lubricants used in the forming process. The cleaned area should extend at least 2" (5.08 mm) beyond either side of a weld joint.

//// Gas Tungsten Arc Welding: DC straight polarity (electrode negative) is recommended. Keep as short an arc length as possible and use care to keep the hot end of filler metal always within the protective atmosphere.

////Shielded Metal Arc Welding: Electrodes should be kept in dry storage and if moisture has been picked up the electrodes should be baked at 600 °F (316 °C) for one hour to insure dryness. Current settings vary from 60 amps for thin material (0.062 thick) up to 140 amps for material of 0.500 thick and heavier. It is best to weave the electrode slightly as this alloy weld metal does not tend to spread. Cleaning of slag is done with a wire brush (hand or powered). Complete removal of all slag is very important before successive weld passes and also after final welding.

////Gas Metal Arc Welding: Reverse-polarity DC should be used and best results are obtained with the welding gun at 90 degrees to the joint. For Short-Circuiting-Transfer GMAW, a typical voltage is 20-23 with a current of 110-130 amps and a wire feed of 250-275 inches per minute (635-698 mm). For Spray-Transfer GMAW, voltage of 25 to 33 and current in the range of 175-300 amps with wire feed rate of 200-350" per minute (508-889 mm) are typical.

////Submerged Arc Welding: Matching filler metal, the same as for GMAW, should be used.
DC current either reverse or straight polarity may be used. Convex weld beads are preferred.

//// MACHINING

////Conventional machining techniques for iron based alloys may be used on **Alloy 825**.
This alloy does work-harden during machining.

////Heavy duty machining equipment and tooling should be used to minimize chatter or work-hardening of the alloy ahead of the cutting. Most any commercial coolant may be used in the machining operations. Water-base coolants are preferred for high speed operations such as turning, grinding, or milling.
Heavy lubricants work best for drilling, tapping, broaching or boring.

////Turning: Carbide tools are recommended for turning with a continuous cut. High-speed steel tooling should be used for interrupted cuts and for smooth finishing to close tolerance. Tools should have a positive rake angle.

////For drilling, steady feed rates must be used to avoid work hardening due to dwelling of the drill on the metal. Rigid set-ups are essential with as short a stub drill as feasible. Heavy-duty, high-speed drills with a heavy web are recommended.

////For milling, to obtain good accuracy and a smooth finish it is essential to have rigid machines and fixtures and sharp cutting tools. High-speed cutters such as M-2 or M-10 work best with cutting speeds of 30-40 feet per minute (914-1 220 cm) and feed of 0.004-0.006” (.01016-.01524 mm) per cutting tooth.

////For grinding, the alloy should be wet ground and aluminum oxide wheels or belts are preferred.