Draka

Alloy 625 Seam Welded Pressure Tubing

Heat treated and cold worked / 90 ksi minimum yield strength
UNS N06625

Applications

Alloy 625 seam welded pressure tubing in the heat treated and cold worked condition is typically used in oil and gas wells for chemical injection applications. In such applications, it is commonly referred to as capillary tubing and is free hanging (self-supporting) inside the production casing. The chemicals being injected are often used to enhance production flow rates, inhibit corrosion or scaling and/or de-water. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden reel, depending on size.

Description

Alloy 625 is an austenitic nickel – chromium – molybdenum - niobium alloy (see Table 1 on reverse). The high alloy content enables alloy 625 to withstand severe aqueous corrosion environments. High molybdenum content (8.0 to 10.0%) makes the alloy very resistant to chloride pitting and crevice corrosion. High nickel content (58.0% min.) provides relative freedom from chloride ion induced stress-corrosion cracking. Alloy 625 has shown excellent corrosion resistance in oil and gas production environments containing hydrogen sulfide, carbon dioxide and chlorides. Consult ISO 15156-3, Table A.14 for the limits regarding material type 4d in hydrogen sulfide containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Strip splice welds join lengths of cold rolled strip to enable long lengths between orbital welds (greater than 5,000 ft between orbital welds is achievable). The strip is formed into a tubular cross section and longitudinally seam welded using either the gas tungsten arc (GTAW) or laser beam welding (LBW) process. The tubing is first sunk to an intermediate outside diameter, heat treated, and joined by orbital welding to achieve the desired length. The tubing is then sunk to the final outside diameter and provided in the as-cold worked condition. Mechanical properties, permissible variation in tubing dimensions, and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

Eddy current testing (ECT) is performed on the longitudinally seam welded tubing and strip splice welds at intermediate size in the as-heat treated condition. Radiographic testing is performed on all orbital welds and those strip splice welds detected by ECT at intermediate size in the as-heat treated condition. Yield pressure hydro static testing is performed on the cold worked tubing at final size.

Standards and Specifications

Tubing Specification PTM-TS-010,
Alloy 625 Tubing with Enhanced Properties

ASTM B704, Standard Specification for Welded UNS N06625, UNS N06219, and UNS N08825 Alloy Tubes, except in the as-cold worked condition

Meets the material limits for annealed and cold-worked, solid-solution, nickel-based alloys listed in ISO 15156-3 for material type 4d in Table A.14.

010 625 W PT CW 0311 01

Alloy 625 Seam Welded Pressure Tubing

Heat treated and cold worked / 90 ksi Minimum Yield Strength

UNS N06625

Table 1 - Chemical Composition, UNS N06625 with further restrictions by Draka Strip Specification, PTM-SS-004, (%)

C	Mn	Si	P	S	Cr	Nb + Ta	Co	Mo	Fe	Al	Ti	Ni
0.05 max	0.50 max	0.50 max	0.015 max	0.015 max	20.0 - 23.0	3.15 - 4.15	1.0 max	8.0 - 10.0	5.0 max	0.40 max	0.40 max	58.0 min

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in^3)	0.305
Modulus of tension elasticity (x10^6 psi)	29.8 at 70º F 28.4 at 400º F
Mean coefficient of thermal expansion (in/in/ºF x 10^{-6}) from 70º F to temperature shown	7.1 to 200º F 7.3 to 400º F

Table 3 - Mechanical Properties

Property	Minimum	Maximum	Typical
Ultimate Tensile Strength UTS, (psi)	–	165,000	138,000
0.2% Offset Yield Strength, YS (psi)	90,000	135,000	105,000
Ratio YS / UTS	–	0.90	0.70
Elongation in 2 inches, E (%)	25	–	32
Hardness, HR30TW	–	93	86

Table 4 - Permissible Variation in Tubing Dimensions

Nominal Outside Diameter (in)	OD (± in)	t (± %)
less than 0.625	0.003	10
greater than or equal to 0.625	0.005	10

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in (mm)	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in^2	Flow Cross Section in^2	Volume per unit Length gal/1000 ft	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.250	0.035	33,617	19,621	0.0236	0.0254	1.3	86.5	2,128	3,262
0.250	0.049	47,063	25,906	0.0309	0.0181	0.9	113.2	2,785	4,270
0.250	0.065	62,431	31,997	0.0378	0.0113	0.6	138.3	3,400	5,213
0.375	0.035	22,500	13,750	0.0374	0.0731	3.8	136.8	3,365	5,159
0.375	0.049	31,500	18,550	0.0502	0.0603	3.1	183.7	4,517	6,925
0.375	0.065	41,786	23,546	0.0633	0.0471	2.4	231.7	5,697	8,736
0.500	0.035	16,909	8,792	0.0511	0.1452	7.5	187.1	4,602	7,056
0.500	0.049	23,672	14,398	0.0694	0.1269	6.6	254.1	6,248	9,581
0.500	0.065	31,402	18,500	0.0888	0.1075	5.6	325.1	7,995	12,258

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:
Minimum ultimate tensile strength, UTS_{min} = 135,000 psi
Minimum 0.2% offset yield strength, YS_{min} = 90,000 psi
Maximum outside diameter, OD_{max} per Table 4
Minimum wall thickness, t_{min} per Table 4
Minimum burst pressure = $(2 \times t_{min} \times UTS_{min}) / OD_{max}$; assumes no axial or other loading except internal pressure.
Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.
The load at typical UTS represents the load to cause failure. Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

www.drakausa.com

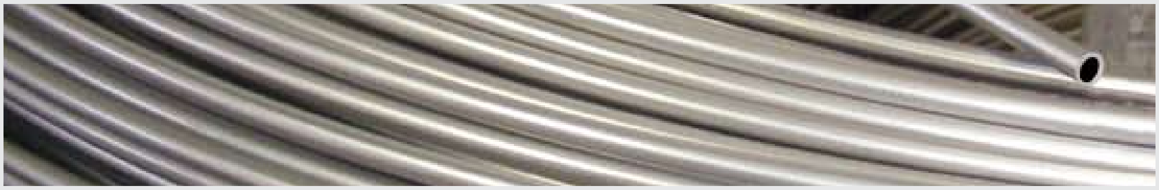
For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Draka

Alloy 825 Seam Welded Pressure Tubing

Heat treated and cold worked / 90 ksi minimum yield strength

UNS N08825



Applications

Alloy 825 seam welded pressure tubing in the heat treated and cold worked condition is typically used in oil and natural gas wells for chemical injection applications. In such applications, it is commonly reffered to as capillary tubing and is free-hanging (self supporting) inside the production casing. The chemicals being injected are often used to enhance production flow rates, inhibit corrosion or scaling and/or de-water. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden reel, depending on size.

Description

Alloy 825 is a titanium-stabilized austenitic nickel-iron-chromium alloy with additions of molybdenum and copper. The chemical composition of the alloy is listed in Table 1. The alloy is characterized by good resistance to stress-corrosion cracking due to its nickel content (38.0 to 46.0) and satisfactory resistance to pitting and crevice corrosion. Alloy 825 has shown good corrosion resistance in oil and gas production environments containing hydrogen sulfide, carbon dioxide and chlorides. Consult ISO 15156-3, Table A.14 for the limits regarding material type 4c in hydrogen sulfide containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Strip splice welds join lengths of cold rolled strip to enable long lengths between orbital welds (greater than 5,000 ft between orbital welds is achievable).

The strip is formed into a tubular cross section and longitudinally seam welded using either the gas tungsten arc (GTAW) or laser beam welding (LBW) process. The tubing is first sunk to an intermediate outside diameter, heat treated, and joined by orbital welding to achieve the desired length. The tubing is then sunk to the final outside diameter and provided in the as-cold worked condition. Mechanical properties, permissible variation in tubing dimensions, and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

Eddy current testing (ECT) is performed on the longitudinally seam welded tubing and strip splice welds at intermediate size in the as-heat treated condition. Radiographic testing is performed on all orbital welds and those strip splice welds detected by ECT at intermediate size in the as-heat treated condition. Yield pressure hydro static testing is performed on the cold worked tubing at final size.

Standards and Specifications

Tubing Specification PTM-TS-006,
Alloy 825 Tubing with Enhanced Properties

ASTM B704, Standard Specification for Welded UNS N06625, UNS N06219, and UNS N08825 Alloy Tubes, except in the as-cold worked condition

Meets the material limits for annealed and cold-worked, solid-solution, nickel-based alloys listed in ISO 15156-3 for material type 4c in Table A.14.

006 825 W PT CW 0311 03

Alloy 825 Seam Welded Pressure Tubing

Heat treated and cold worked / 90 ksi minimum yield strength

UNS N08825

Table 1 - Chemical Composition, UNS N08825 with further restrictions by Draka Strip Specification, PTM-SS-003, (%)

Ni	Cr	Fe	Mn	C	Cu	Si	S	P	Al	Ti	Mo	B
38.0 - 46.0	21.5 - 23.5	22.0 min	1.0 max	0.020 max	1.5 - 3.0	0.5 max	0.005 max	0.020 max	0.2 max	0.6 - 1.2	2.5 - 3.5	0.006 max

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in^3)	0.293
Modulus of tension elasticity (x10^6 psi)	28.3 at 70º F
	26.8 at 400º F
Mean coefficient of thermal expansion from 70º F	7.8 to 200º F
to temperature shown (in/in/ºF x 10^{-6})	8.3 to 400º F

Table 3 - Mechanical Properties

Property	Minimum	Maximum	Typical
Ultimate Tensile Strength UTS, (psi)	–	150,000	120,000
0.2% Offset Yield Strength, YS (psi)	90,000	135,000	100,000
Ratio YS / UTS	–	0.93	0.85
Elongation in 2 inches, E (%)	5	–	10
Hardness, HR30TW	–	90	86

Table 4 - Permissible Variation in Tubing Dimensions

Nominal Outside Diameter (in)	OD (± in)	t (± %)
less than 0.625	0.003	10
greater than or equal to 0.625	0.005	10

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in (mm)	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in^2	Flow Cross Section in^2	Volume per unit Length gal/1000 ft	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.250	0.035	27,391	19,621	0.0236	0.0254	1.3	83.1	2,128	2,837
0.250	0.049	38,348	25,906	0.0309	0.0181	0.9	108.8	2,785	3,713
0.250	0.065	50,870	31,997	0.0378	0.0113	0.6	132.8	3,400	4,533
0.375	0.035	18,333	13,750	0.0374	0.0731	3.8	131.4	3,365	4,486
0.375	0.049	25,667	18,550	0.0502	0.0603	3.1	176.4	4,517	6,022
0.375	0.065	34,048	23,546	0.0633	0.0471	2.4	222.6	5,697	7,596
0.500	0.035	13,777	8,792	0.0511	0.1452	7.5	179.8	4,602	6,136
0.500	0.049	19,288	14,398	0.0694	0.1269	6.6	244.1	6,248	8,331
0.500	0.065	25,586	18,500	0.0888	0.1075	5.6	312.3	7,995	10,659

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:
Minimum ultimate tensile strength, UTS_{min} = 110,000 psi
Minimum 0.2% offset yield strength, YS_{min} = 90,000 psi
Maximum outside diameter, OD_{max} per above table
Minimum wall thickness, t_{min} per above table
Minimum burst pressure = $(2 \times t_{min} \times UTS_{min}) / OD_{max}$; assumes no axial or other loading except internal pressure.
Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.
The load at typical UTS represents the load to cause failure. Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

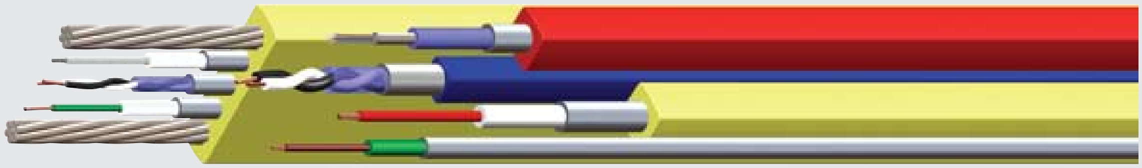
www.drakausa.com

For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Alloy 316L Seam Welded Sheathed Tubing

Cold worked / 90 ksi minimum yield strength

UNS S31603



Applications

Alloy 316L seam welded sheathed tubing, which is commonly referred to as TEC, is typically used in oil, natural gas and geothermal wells to provide power and communication to downhole gauges. TEC contains a core consisting of insulated electrical conductor(s) and/or optical fiber(s). The tubing is generally deployed by strapping it to the outside of the production casing. However, it may also be free hanging (self-supporting) inside the production casing. It may be encapsulated and can be included along with pressure tubing and mechanical components, such as bumpers, within a flatpack. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden or steel reel, depending on size.

Description

Alloy 316L is a chromium - nickel austenitic stainless steel with an addition of molybdenum and reduced carbon content. The addition of molybdenum provides improved resistance to pitting and crevice corrosion in environments containing halides such as chlorides when compared to so-called conventional 18 chromium 8 nickel austenitic stainless steels such as 304L. The reduced carbon content minimizes harmful chromium carbide precipitation during welding and thereby improves resistance to intergranular corrosion. Austenitic stainless steels such as 316L are susceptible to stress corrosion cracking (SCC) in environments containing chlorides and other halides. Alloy 316L is generally used in oil and gas production environments which do not contain oxygen and have limited amounts of chlorides and hydrogen sulfide. Consult ISO 15156-3, Table A.7 for the limits regarding alloy 316L in hydrogen sulfide containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Strip splice welds, which are used to join lengths of cold rolled strip, enable long continuous lengths of tubing to be manufactured. The strip is formed into a tubular cross section around the core and longitudinally seam welded using the gas tungsten arc welding (GTAW) process. The tubing is seam welded at a larger outside diameter to protect the core and then sunk to final size. The final material condition of the tubing is cold worked. Mechanical properties, permissible variation in tubing dimensions and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

In-process eddy current testing (ECT) is performed on the as-welded tubing and final ECT is performed on the as-sunk tubing. Visual examination is performed on all ECT indications. Performance of additional NDT is dependent upon both the type of core and specific customer requirements, and may include: electrical continuity, high voltage/bending; insulation resistance, optical time domain reflectometer, and high pressure nitrogen underwater.

Standards and Specifications

Tubing Specification PTM-TS-001, Alloy 316L Sheathed Insulated Electrical Conductors and Optical Fibers

ASTM A554, Standard Specification for Welded Stainless Steel Mechanical Tubing

Meets the material limits for austenitic stainless steel listed in ISO 15156-3, Table A.7

Alloy 316L Seam Welded Sheathed Tubing

Cold worked / 90 ksi minimum yield strength

UNS S31603

Table 1 - Chemical Composition, UNS S31603 with further restrictions by Draka Strip Specifications PTM-SS-002 or PTM-SS-006, (%)

C	Mn	P	S	Si	Cr	Ni	Mo	N	Cu	Fe
0.030 max	2.00 max	0.040 max	0.017 max	0.75 max	16.0 - 18.0	10.0 - 14.0	2.00 - 3.00	0.10 max	0.50 max	Bal

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in^3)	0.290
Modulus of tension elasticity (x 10^6)	29.0 at 70°F
Mean coefficient of thermal expansion from 70°F to temperature shown (in/in/°F x 10^{-6})	9.2 to 200°F

Table 3 - Mechanical Properties

Property	Minimum	Typical
Ultimate Tensile Strength UTS, (psi)	100,000	140,000 to 160,000
0.2% Offset Yield Strength, YS (psi)	90,000	115,000 to 130,000
Elongation in 2 inches, E (%)	–	5 to 15
Vickers Hardness, HV5 (5 kg load)	–	300 to 340

Note: Typical properties vary with the amount of cold work. Vickers Hardness testing was performed in weld metal and base metal regions on mounted cross sections.

Table 4 - Permissible Variation in Tubing Dimensions

Dimension	Permissible Variation
Nominal Outside Diameter (in)	± 0.002
Nominal Wall Thickness 0.022-in.	0.0200 to 0.0225
Nominal Wall Thickness 0.028-in.	0.0255 to 0.0285
Nominal Wall Thickness 0.035-in.	0.0315 to 0.0355
Nominal Wall Thickness 0.049-in.	0.0445 to 0.0495

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in^2	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.125	0.022	31,496	23,882	0.0071	24.8	641	1,068
0.125	0.028	40,157	28,885	0.0085	29.7	768	1,280
0.1875	0.035	33,245	24,947	0.0168	58.4	1,509	2,515
0.250	0.028	20,238	16,371	0.0195	68.0	1,758	2,929
0.250	0.035	25,000	19,688	0.0236	82.3	2,128	3,546
0.250	0.049	35,317	26,173	0.0309	107.7	2,785	4,641
0.3125	0.049	28,299	21,865	0.0406	141.2	3,651	6,084
0.375	0.035	16,711	13,783	0.0374	130.1	3,365	5,608
0.375	0.049	23,607	18,739	0.0502	174.6	4,517	7,528

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:

Minimum ultimate tensile strength, UTS_{min} and minimum 0.2% offset yield strength, YS_{min} per above table.

Maximum outside diameter, OD_{max} per above table

Minimum wall thickness, t_{min} per above table

Minimum burst pressure = $(2 \times t_{min} \times UTS_{min}) / OD_{max}$; assumes no axial or other loading except internal pressure.

Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.

The load at typical UTS represents the load to cause failure. The UTS used in the calculation of the load at typical UTS was 150,000 psi.

Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Draka

Alloy 825 Seam Welded Pressure Tubing

Heat treated / 35 ksi minimum yield strength

UNS N08825

Applications

Alloy 825 seam welded pressure tubing in the heat treated condition is typically used in oil and natural gas wells for applications including hydraulically actuated surface-controlled subsurface safety valves, chemical injection, and instrumentation. In such applications, it is commonly referred to as control line tubing.

The tubing is generally deployed by strapping it to the outside of the production casing. It may be encapsulated and can be included along with other pressure tubing or TEC and mechanical components, such as bumpers, within a flatpack. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden or steel reel, depending on size.

Description

Alloy 825 is a titanium-stabilized austenitic nickel-iron - chromium alloy with additions of molybdenum and copper. The chemical composition of the alloy is listed in Table 1. The alloy is characterized by good resistance to stress-corrosion cracking due to its nickel content (38.0 to 46.0) and satisfactory resistance to pitting and crevice corrosion.

Alloy 825 has shown good corrosion resistance in oil and gas production environments containing hydrogen sulfide, carbon dioxide and chlorides. Consult ISO 15156-3, Table A.14 for the limits regarding material type 4c in hydrogen sulfide containing environments for oil and gas production.

Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Strip splice welds join lengths of cold rolled strip to enable long lengths between orbital welds (greater than 5,000 ft between orbital welds is achievable). The strip is formed into a tubular cross section and longitudinally seam welded using either the gas tungsten arc (GTAW) or laser beam welding (LBW) process. The tubing may be welded at a larger outside diameter, sunk to final size and subsequently heat treated. Heat treated tubing is joined by orbital welding to achieve the desired length. The final material condition of the tubing is heat treated. Mechanical properties, permissible variation in tubing dimensions and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

Eddy current testing (ECT) is performed on the longitudinally seam welded tubing and strip splice welds in the as-heat treated condition. Radiographic testing is performed on all orbital welds and those strip splice welds detected by ECT. Yield pressure hydrostatic testing is performed on the heat treated tubing at final size.

Standards and Specifications

Tubing Specification PTM-TS-002, Alloy 825 Tubing for Control Line Applications

ASTM B704, Standard Specification for Welded UNS N06625, UNS N06219, and UNS N08825 Alloy Tubes

Meets the material limits for annealed and cold-worked, solid-solution, nickel-based alloys listed in ISO 15156-3, for Material Type 4c in Table A.14

Alloy 825 Seam Welded Pressure Tubing

Heat treated / 35 ksi minimum yield strength

UNS N08825

Table 1 - Chemical Composition, UNS N08825 with further restrictions by Draka Strip Specification, PTM-SS-003, (%)

Ni	Cr	Fe	Mn	C	Cu	Si	S	P	Al	Ti	Mo	B
38.0 - 46.0	21.5 - 23.5	22.0 min	1.0 max	0.020 max	1.5 - 3.0	0.5 max	0.005 max	0.020 max	0.2 max	0.6 - 1.2	2.5 - 3.5	0.006 max

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in^3)	0.293
Modulus of tension elasticity (x 10^6 psi)	28.3 at 70°F
	26.8 at 400°F
Mean coefficient of thermal expansion from	7.8 to 200°F
70°F to temperature shown (in/in/°F x 10^{-6})	8.3 to 400°F

Table 3 - Mechanical Properties

Property	Minimum	Maximum	Typical
Ultimate Tensile Strength UTS, (psi)	85,000	–	100,000
0.2% Offset Yield Strength, YS (psi)	35,000	–	50,000
Elongation in 2 inches, E (%)	30	–	38
Hardness, HR30TW	–	85	70

Table 4 - Permissible Variation in Tubing Dimensions

Nominal Outside Diameter (in)	OD (± in)	t (± %)
less than 0.625	0.003	10
equal to or greater than 0.625	0.005	10

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in (mm)	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in^2	Flow Cross Section in^2	Volume per unit Length gal/1000 ft	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.250	0.035	21,166	7,630	0.0236	0.0254	1.3	83.1	827	2,364
0.250	0.049	29,632	10,075	0.0309	0.0181	0.9	108.8	1,083	3,094
0.250	0.065	39,308	12,443	0.0378	0.0113	0.6	132.8	1,322	3,778
0.375	0.035	14,167	5,347	0.0374	0.0731	3.8	131.4	1,308	3,738
0.375	0.049	19,833	7,214	0.0502	0.0603	3.1	176.4	1,756	5,018
0.375	0.065	26,310	9,157	0.0633	0.0471	2.4	222.6	2,216	6,330
0.500	0.035	10,646	4,109	0.0511	0.1452	7.5	179.8	1,790	5,113
0.500	0.049	14,905	5,599	0.0694	0.1269	6.6	244.1	2,430	6,943
0.500	0.065	19,771	7,194	0.0888	0.1075	5.6	312.3	3,109	8,883

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:

Minimum ultimate tensile strength, UTS_{min} and minimum 0.2% offset yield strength, YS_{min} per above table.
Maximum outside diameter, OD_{max} per above table
Minimum wall thickness, t_{min} per above table
Minimum burst pressure = $(2 \times t_{min} \times UTS_{min}) / OD_{max}$; assumes no axial or other loading except internal pressure.
Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.
The load at typical UTS represents the load to cause failure. Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

www.drakausa.com

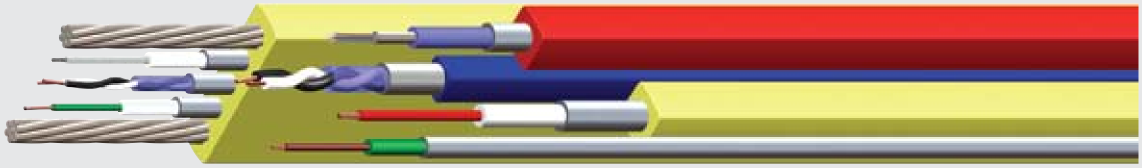
For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Draka

Alloy 825 Seam Welded Sheathed Tubing

Cold worked / 95 ksi minimum yield strength

UNS N08825



Applications

Alloy 825 seam welded sheathed tubing, which is commonly referred to as TEC, is typically used in oil, natural gas and geothermal wells to provide power and communication to down-hole gauges. TEC contains a core consisting of insulated electrical conductor(s) and/or optical fiber(s). The tubing is generally deployed by strapping it to the outside of the production casing. However, it may also be free hanging (self-supporting) inside the production casing. It may be encapsulated and can be included along with pressure tubing and mechanical components, such as bumpers, within a flatpack. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden or steel reel, depending on size.

Description

Alloy 825 is a titanium-stabilized austenitic nickel - iron - chromium alloy with additions of molybdenum, and copper. The chemical composition of the alloy is listed in Table 1. The alloy is characterized by good resistance to stress-corrosion cracking due to its nickel content (38.0 to 46.0) and satisfactory resistance to pitting and crevice corrosion. Alloy 825 has shown good corrosion resistance in oil and gas production environments containing hydrogen sulfide, carbon dioxide and chlorides. Consult ISO 15156-3, Table A.14 for the limits regarding material type 4c in hydrogen sulfide containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Strip splice welds, which are used to join lengths of cold rolled strip, enable long continuous lengths of tubing to be manufactured. The strip is formed into a tubular cross section around the core and longitudinally seam welded using the gas tungsten arc welding (GTAW) process. The tubing is seam welded at a larger outside diameter to protect the core and then sunk to final size. The final material condition of the tubing is cold worked. Mechanical properties, permissible variation in tubing dimensions and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

In-process eddy current testing (ECT) is performed on the as-welded tubing and final ECT is performed on the as-sunk tubing. Visual examination is performed on all ECT indications. Performance of additional NDT is dependent upon both the type of core and specific customer requirements, and may include: electrical continuity, high voltage/bending; insulation resistance, optical time domain reflectometer, and high pressure nitrogen underwater.

Standards and Specifications

Tubing Specification PTM-TS-003, Alloy 825 Sheathed Insulated Electrical Conductors and Optical Fibers

ASTM B704, Standard Specification for Welded UNS N06625, UNS N06219, and UNS N08825 Alloy Tubes

Meets the material limits for material type 4c listed in ISO 15156-3, Table A.14, except no heat treatment after welding.

003 825 W ST 0311 09

Alloy 825 Seam Welded Sheathed Tubing

Cold worked / 95 ksi minimum yield strength

UNS N08825

Table 1 - Chemical Composition, UNS N08825 with further restrictions by Draka Strip Specification, PTM-TS-003, (%)

Ni	Cr	Fe	Mn	C	Cu	Si	S	P	Al	Ti	Mo	B
38.0 - 46.0	21.5 - 23.5	22.0 min	1.0 max	0.020 max	1.5 - 3.0	0.5 max	0.005 max	0.020 max	0.2 max	0.6 - 1.2	2.5 - 3.5	0.006 max

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in^3)	0.293
Modulus of tension elasticity (x 10^6 psi)	28.3 at 70°F
	26.8 at 400°F
Mean coefficient of thermal expansion from 70°F to temperature shown (in/in/°F x 10^{-6})	7.8 to 200°F 8.3 to 400°F

Table 3 - Mechanical Properties

Property	Minimum	Typical
Ultimate Tensile Strength UTS, (psi)	110,000	140,000 to 160,000
0.2% Offset Yield Strength, YS (psi)	95,000	120,000 to 140,000
Elongation in 2 inches, E (%)	–	5 to 10
Vickers Hardness, HV5 (5 kg load)	–	285 to 310

Note: Typical properties vary with the amount of cold work. Vickers Hardness testing was performed in weld metal and base metal regions on mounted cross sections.

Table 4 - Permissible Variation in Tubing Dimensions

Dimension	Permissible Variation
Nominal Outside Diameter (in)	± 0.002
Nominal Wall Thickness 0.022-in.	0.0200 to 0.0225
Nominal Wall Thickness 0.028-in.	0.0255 to 0.0285
Nominal Wall Thickness 0.035-in.	0.0315 to 0.0355
Nominal Wall Thickness 0.049-in.	0.0445 to 0.0495

Table 5 - Size Dependent Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in^2	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.125	0.022	34,646	25,209	0.0071	25.0	676	1,068
0.125	0.028	44,173	30,490	0.0085	30.0	811	1.280
0.1875	0.035	36, 570	26,333	0.0168	59.0	1,593	2,515
0.250	0.028	22,262	17,281	0.0195	68.7	1,855	2,929
0.250	0.035	27,500	20,781	0.0236	83.1	2,246	3,546
0.250	0.049	38,849	27,627	0.0309	108.8	2,939	4,641
0.3125	0.049	31,129	23,080	0.0406	142.6	3.853	6,084
0.375	0.035	18,382	14,549	0.0374	131.4	3,552	5,608
0.375	0.049	25,968	19,780	0.0502	176.4	4,767	7.528

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:

Minimum ultimate tensile strength, UTS_{min} and minimum 0.2% offset yield strength, YS_{min} per above table.

Maximum outside diameter, OD_{max} per above table

Minimum wall thickness, t_{min} per above table

Minimum burst pressure = (2 x t_{min} x UTS_{min}) / OD_{max}; assumes no axial or other loading except internal pressure.

Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.

The load at typical UTS represents the load to cause failure. The UTS used in the calculation of the load at typical UTS was 150,000 psi.

Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Draka

Alloy 316L Seam Welded Pressure Tubing

Heat treated / 30 ksi minimum yield strength

UNS S31603

Applications

Alloy 316L seam welded pressure tubing in the heat treated condition is typically used in oil and natural gas wells for applications including hydraulically actuated surface-controlled subsurface safety valves, chemical injection, and instrumentation. In such applications, it is commonly referred to as control line tubing. The tubing is generally deployed by strapping it to the outside of the production casing. It may be encapsulated and can be included along with other pressure tubing or TEC and mechanical components, such as bumpers, within a flatpack. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden or steel reel, depending on size.

Description

Alloy 316L is a chromium-nickel austenitic stainless steel with an addition of molybdenum and reduced carbon content. The addition of molybdenum provides improved resistance to pitting and crevice corrosion in environments containing halides such as chlorides when compared to so-called conventional 18 chromium 8 nickel austenitic stainless steels such as 304L. The reduced carbon content minimizes harmful chromium carbide precipitation during welding and thereby improves resistance to intergranular corrosion. Austenitic stainless steels such as 316L are susceptible to stress corrosion cracking (SCC) in environments containing chlorides and other halides. Alloy 316L is generally used in oil and gas production environments which do not contain oxygen and have limited amounts of chlorides and hydrogen sulfide. Consult ISO 15156-3, Table A.2 for the limits regarding alloy 316L in hydrogen sulfide-containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Strip splice welds join lengths of cold rolled strip to enable long lengths between orbital welds (greater than 5,000 ft. between orbital welds is achievable).

The strip is formed into a tubular cross section and longitudinally seam welded using either the gas tungsten arc (GTAW) or laser beam welding (LBW) process. The tubing may be welded at a larger outside diameter, sunk to final size and subsequently heat treated. Heat treated tubing is joined by orbital welding to achieve the desired length. The final material condition of the tubing is heat treated.

Mechanical properties, permissible variation in tubing dimensions and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

Eddy current testing (ECT) is performed on the longitudinally seam welded tubing and strip splice welds in the as-heat treated condition. Radiographic testing and ECT are performed on material in the final heat treated condition. Radiographic testing is performed on all orbital welds and those strip splice welds detected by ECT. Yield pressure hydrostatic testing is performed on the heat treated tubing at final size.

Standards and Specifications

Tubing Specification PTM-TS-004, Alloy 316L Tubing for Control Line Applications

ASTM A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

Meets the material limits for 316L austenitic stainless steel listed in ISO 15156-3, Table A.2

Alloy 316L Seam Welded Pressure Tubing

Heat treated / 30 ksi minimum yield strength

UNS S31603

Table 1 - Chemical Composition, UNS S31603 with further restrictions by Draka Strip Specifications PTM-SS-002 or PTM-SS-006, (%)

C	Mn	P	S	Si	Cr	Ni	Mo	N	Cu	Fe
0.030 max	2.00 max	0.040 max	0.017 max	0.75 max	16.0 - 18.0	10.0 - 14.0	2.00 - 3.00	0.10 max	0.50 max	Bal

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in^3)	0.290
Modulus of tension elasticity (x 10^6 psi)	29.0 at 70°F
Mean coefficient of thermal expansion from 70°F to temperature shown (in/in/°F x 10^{-6})	9.2 to 200°F

Table 3 - Mechanical Properties

Property	Minimum	Maximum	Typical
Ultimate Tensile Strength UTS, (psi)	75,000	–	90,000
0.2% Offset Yield Strength, YS (psi)	30,000	–	43,000
Elongation in 2 inches, E (%)	35	–	50
Hardness, HR30TW	–	70	66

Table 4 - Permissible Variation in Tubing Dimensions

Nominal Outside Diameter (in)	OD (± in)	t (± %)
less than 0.625	0.003	10
equal to or greater than 0.625	0.005	10

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in (mm)	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in^2	Flow Cross Section in^2	Volume per unit Length gal/1000 ft	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.250	0.035	18,676	6,540	0.0236	0.0254	1.3	82.3	709	2,128
0.250	0.049	26,146	8,635	0.0309	0.0181	0.9	107.7	928	2,785
0.250	0.065	34,684	10,666	0.0378	0.0113	0.6	131.5	1,133	3,400
0.375	0.035	12,500	4,583	0.0374	0.0731	3.8	130.1	1,122	3,365
0.375	0.049	17,500	6,183	0.0502	0.0603	3.1	174.6	1,506	4,517
0.375	0.065	23,214	7,849	0.0633	0.0471	2.4	220.3	1,899	5,697
0.500	0.035	9,394	3,522	0.0511	0.1452	7.5	177.9	1,534	4,602
0.500	0.049	13,151	4,799	0.0694	0.1269	6.6	241.6	2,083	6,248
0.500	0.065	17,445	6,167	0.0888	0.1075	5.6	309.1	2,665	7,995

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:

Minimum ultimate tensile strength, UTS_{min} and minimum 0.2% offset yield strength, YS_{min} per above table.

Maximum outside diameter, OD_{max} per above table

Minimum wall thickness, t_{min} per above table

Minimum burst pressure = $(2 \times t_{min} \times UTS_{min}) / OD_{max}$; assumes no axial or other loading except internal pressure.

Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.

The load at typical UTS represents the load to cause failure. Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

www.drakausa.com

For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Draka

Alloy 2205 Seam Welded Pressure Tubing

Heat treated / 80 ksi minimum yield strength

UNS S32205

Applications

Alloy 2205 seam welded pressure tubing in the heat treated condition is typically used in oil and natural gas wells for chemical injection applications. In such applications, it is commonly referred to as capillary tubing and is free-hanging (self-supporting) inside the production casing. The chemicals being injected are often used to enhance production flow rates, inhibit corrosion or scaling and/or de-water. However, the tubing can also be used for control line tubing applications including hydraulically actuated surface-controlled subsurface safety valves. For control line applications, the tubing is generally deployed by strapping it to the outside of the production casing. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden or steel reel, depending on size.

Description

Alloy 2205 is a duplex stainless steel. When properly heat treated, the microstructure consists of a nearly equal mixture of the austenitic and ferrite phases. This two-phase microstructure produces a fine grain size which increases the yield strength. In the final heat treated condition, alloy 2205 can achieve a yield strength approximately twice that of austenitic alloys such as 316L, 825 and 625 which must be cold worked to achieve comparable yield strengths. Duplex stainless steels are often classified as lean, conventional, super or hyper based upon their pitting resistance equivalent (PRE or PREN). Various PRE formulas are used to rank an alloy's resistance to chloride pitting corrosion based upon its composition. Alloy 2205 typically has a PRE of 36 and is considered a conventional duplex stainless steel. Alloy 2205 is often selected for use in oil and gas production environments based upon its higher strength and resistance to pitting, crevice and stress corrosion cracking in chloride containing environments.

Consult ISO 15156-3, Table A.24 for the limits regarding the use of alloy 2205 in hydrogen sulfide containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Strip splice welds join lengths of cold rolled strip to enable long lengths between orbital welds (greater than 5,000 ft between orbital welds is achievable). The strip is formed into a tubular cross section and longitudinally seam welded using either the gas tungsten arc (GTAW) or laser beam welding (LBW) process. The tubing may be welded at a larger outside diameter, sunk to final size and subsequently heat treated. The heat treated tubing is joined by orbital welding to achieve the desired length. The final material condition of the tubing is heat treated. Mechanical properties, permissible variation in tubing dimensions and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

Eddy current testing (ECT) is performed on the longitudinally seam welded tubing and strip splice welds in the as-heat treated condition. Radiographic testing is performed on all orbital welds and those strip splice welds detected by ECT. Yield pressure hydrostatic testing is performed on the heat treated tubing at final size.

Standards and Specifications

Tubing Specification PTM-TS-011, Alloy 2205 Tubing for Control Line Applications

ASTM A789, Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service

Meets the material limits for duplex stainless steel with PREN 30 to 40 as listed in ISO 15156-3, Table A.24

Alloy 2205 Seam Welded Pressure Tubing

Heat treated / 80 ksi minimum yield strength

UNS S32205

Table 1 - Chemical Composition, UNS S32205 with further restrictions by Draka Strip Specification PTM-SS-005, (%).

C	Mn	P	S	Si	Cr	Ni	Mo	N	Fe
0.030 max	2.00 max	0.030 max	0.005 max	1.00 max	22.0 - 23.0	4.5 - 6.5	3.0 - 3.5	0.14 - 0.20	Bal

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in³)	0.283
Modulus of tension elasticity (x 10^6)	29.0 at 70°F
Mean coefficient of thermal expansion from 70°F to temperature shown (in/in/°F x 10^{-6})	7.2 to 200°F

Table 3 - Mechanical Properties

Property	Minimum	Maximum	Typical
Ultimate Tensile Strength UTS, (psi)	110,000	–	125,000
0.2% Offset Yield Strength, YS (psi)	80,000	–	90,000
Elongation in 2 inches, E (%)	25	–	30
Hardness, HR30TW	–	90	85

Table 4 - Permissible Variation in Tubing Dimensions

Nominal Outside Diameter (in)	OD (± in)	t (± %)
less than 0.625	0.003	10
equal to or greater than 0.625	0.005	10

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in²	Flow Cross Section in²	Volume per unit Length gal/1000 ft	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.250	0.035	27,391	17,441	0.0236	0.0254	1.3	80.3	1,891	2,955
0.250	0.049	38,348	23,028	0.0309	0.0181	0.9	105.1	2,475	3,868
0.250	0.065	50,870	28,442	0.0378	0.0113	0.6	128.3	3,022	4,722
0.375	0.035	18,333	12,222	0.0374	0.0731	3.8	127.0	2,991	4,673
0.375	0.049	25,667	16,489	0.0502	0.0603	3.1	170.4	4,015	6,273
0.375	0.065	34,048	20,930	0.0633	0.0471	2.4	215.0	5,064	7,913
0.500	0.035	13,777	8,091	0.0511	0.1452	7.5	173.6	4,090	6,391
0.500	0.049	19,288	12,798	0.0694	0.1269	6.6	235.8	5,554	8,678
0.500	0.065	25,586	16,444	0.0888	0.1075	5.6	301.7	7,106	11,104

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:

Minimum ultimate tensile strength, UTS_{min} and minimum 0.2% offset yield strength, YS_{min} per above table.

Maximum outside diameter, OD_{max} per above table

Minimum wall thickness, t_{min} per above table

Minimum burst pressure = (2 x t_{min} x UTS_{min}) / OD_{max}; assumes no axial or other loading except internal pressure.

Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.

The load at typical UTS represents the load to cause failure. Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

www.drakausa.com

For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Alloy 316L Seamless Pressure Tubing

Heat treated / 30 ksi minimum yield strength

UNS S31603

Applications

Alloy 316L seamless pressure tubing in the heat treated condition is typically used in oil and natural gas wells for applications including hydraulically-actuated surface-controlled subsurface safety valves, chemical injection, and instrumentation. In such applications, it is commonly referred to as control line tubing. The tubing is generally deployed by strapping it to the outside of the production casing. It may be encapsulated and can be included along with other pressure or TEC and mechanical components, such as bumpers, within a flatpack. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden or steel reel, depending on size.

Description

Alloy 316L is a chromium - nickel austenitic stainless steel with an addition of molybdenum and reduced carbon content. The addition of molybdenum provides improved resistance to pitting and crevice corrosion in environments containing halides such as chlorides when compared to so-called conventional 18 chromium 8 nickel austenitic stainless steels such as 304L. The reduced carbon content minimizes harmful chromium carbide precipitation during welding and thereby improves resistance to intergranular corrosion. Austenitic stainless steels such as 316L are susceptible to stress corrosion cracking (SCC) in environments containing chlorides and other halides. Alloy 316L is generally used in oil and gas production environments which do not contain oxygen and have limited amounts of chlorides and hydrogen sulfide.

Consult ISO 15156-3, Table A.2 for the limits regarding alloy 316L in hydrogen sulfide containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Seamless extruded tube hollows are drawn or drawn / sunk to final size to produce seamless tubing coils 500 to 2,000 ft. long, depending upon the size. The tubing is heat treated and joined by orbital welding to achieve the desired length. The final material condition of the tubing is heat treated. Mechanical properties, permissible variation in tubing dimensions and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

Eddy current testing (ECT) is performed at final size in the heat treated condition. Radiographic testing is performed on all orbital welds. Yield pressure hydrostatic testing is performed on the heat treated tubing at final size.

Standards and Specifications

Tubing Specification PTM-TS-022, Alloy 316L Seamless Tubing for Control Line Applications

ASTM A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

Meets the material limits for 316L austenitic stainless steel listed in ISO 15156-3, Table A.2.

Alloy 316L Seamless Pressure Tubing

Heat treated / 30 ksi minimum yield strength

UNS S31603

Table 1 - Chemical Composition, UNS S31603 with further restrictions by Draka Strip Specification, PTM-TPS-001, (%)

C	Mn	P	S	Si	Cr	Ni	Mo	N	Cu	B	C+N	Fe
0.030 max	2.00 max	0.040 max	0.005-0.010	0.75 max	16.0-18.0	10.0-14.0	2.00-3.00	0.10 max	0.50 max	0.0010 max	0.060	Bal

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in³)	0.290
Modulus of tension elasticity (x 10^6 psi)	29 at 70°F
Mean coefficient of thermal expansion from 70°F to temperature shown (in/in/°F x 10^{-6})	9.2 to 200°F

Table 3 - Mechanical Properties

Property	Minimum	Maximum	Typical
Ultimate Tensile Strength UTS, (psi)	75,000	–	77,500
0.2% Offset Yield Strength, YS (psi)	30,000	–	33,500
Elongation in 2 inches, E (%)	35	–	55
Hardness, HRBW	–	90	66

Table 4 - Permissible Variation in Tubing Dimensions

Nominal Outside Diameter (in)	OD (in)	t (± %)
less than 0.625	±0.003	10
equal to or greater than 0.625	+0.004, -0.003	10

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in (mm)	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in²	Flow Cross Section in²	Volume per unit Length gal/1000 ft	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.250	0.035	18,676	6,540	0.0236	0.0254	1.3	82.3	709	1,832
0.250	0.049	26,146	8,635	0.0309	0.0181	0.9	107.7	928	2,398
0.250	0.065	34,684	10,666	0.0378	0.0113	0.6	131.5	1,133	2,928
0.375	0.035	12,500	4,583	0.0374	0.0731	3.8	130.1	1,122	2,897
0.375	0.049	17,500	6,183	0.0502	0.0603	3.1	174.6	1,506	3,889
0.375	0.065	23,214	7,849	0.0633	0.0471	2.4	220.3	1,899	4,906
0.500	0.035	9,394	3,522	0.0511	0.1452	7.5	177.9	1,534	3,963
0.500	0.049	13,151	4,799	0.0694	0.1269	6.6	241.6	2,083	5,381
0.500	0.065	17,445	6,167	0.0888	0.1075	5.6	309.1	2,665	6,884

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:

Minimum ultimate tensile strength, UTS_{min} and minimum 0.2% offset yield strength, YS_{min} per above table.

Maximum outside diameter, OD_{max} per above table

Minimum wall thickness, t_{min} per above table

Minimum burst pressure = (2 x t_{min} x UTS_{min}) / OD_{max}; assumes no axial or other loading except internal pressure.

Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.

The load at typical UTS represents the load to cause failure. Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

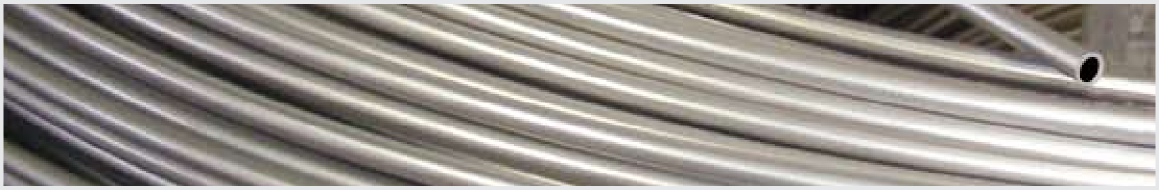
www.drakausa.com

For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Alloy 825 Seamless Pressure Tubing

Heat treated / 35 ksi minimum yield strength

UNS N08825



Applications

Alloy 825 seamless pressure tubing in the heat treated condition is typically used in oil and natural gas wells for applications including hydraulically actuated surface-controlled subsurface safety valves, chemical injection, and instrumentation. In such applications, it is commonly referred to as control line tubing. The tubing is generally deployed by strapping it to the outside of the production casing. It may be encapsulated and can be included along with other pressure or TEC and mechanical components, such as bumpers, within a flatpack. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden or steel reel, depending on size.

Description

Alloy 825 is a titanium-stabilized austenitic nickel - iron - chromium alloy with additions of molybdenum, and copper. The chemical composition of the alloy is listed in Table 1. The alloy is characterized by good resistance to stress-corrosion cracking due to its nickel content (38.0 to 46.0) and satisfactory resistance to pitting and crevice corrosion. Alloy 825 has shown good corrosion resistance in oil and gas production environments containing hydrogen sulfide, carbon dioxide and chlorides. Consult ISO 15156-3, Table A.14 for the limits regarding material type 4c in hydrogen sulfide containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Seamless extruded tube hollows are drawn or drawn/sunk to final size to produce seamless tubing coils 500 to 2,000 ft long, depending upon the size. The tubing is heat treated and joined by orbital welding to achieve the desired length. The final material condition of the tubing is heat treated. Mechanical properties, permissible variation in tubing dimensions and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively.

Nondestructive Testing (NDT)

Eddy current testing (ECT) is performed at final size in the heat treated condition. Radiographic testing is performed on all orbital welds. Yield pressure hydrostatic testing is performed on the heat treated tubing at final size.

Standards and Specifications

Tubing Specification PTM-TS-023, Alloy 825 Seamless Tubing for Control Line Applications

ASTM B423, Standard Specification for Nickel-Iron-Chromium–Molybdenum-Copper Alloy (UNS N08825 and N08221) Seamless Pipe and Tube

Meets the material limits for material type 4c listed in ISO 15156-3, Table A.14.

Alloy 825 Seamless Pressure Tubing

Heat treated / 35 ksi minimum yield strength

UNS N08825

Table 1 - Chemical Composition, UNS N08825 with further restrictions by Draka Tubing Procurement Specification, PTM-TPS-002, (%)

Ni	Cr	Fe	Mn	C	Cu	Si	S	Al	Ti	Mo
38.0 - 46.0	19.5-23.5	22.0 min	1.0 max	0.03 max	1.5-3.0	0.5 max	0.03 max	0.2 max	0.6-1.2	2.5 - 3.5

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in³)	0.293
Modulus of tension elasticity (x10⁶ psi)	28.3 at 70º F
	26.8 at 400º F
Mean coefficient of thermal expansion from 70º F	7.8 to 200º F
to temperature shown (in/in/ºF x 10⁻⁶)	8.3 to 400º F

Table 3 - Mechanical Properties

Property	Minimum	Maximum	Typical
Ultimate Tensile Strength UTS, (psi)	85,000	—	100,500
0.2% Offset Yield Strength, YS (psi)	35,000	—	40,500
Elongation in 2 inches, E (%)	30	—	48
Hardness, HRBW	—	90	75

Table 4 - Permissible Variation in Tubing Dimensions

Nominal Outside Diameter (in)	OD (in)	t (± %)
less than 0.625	±0.003	10
greater than or equal to 0.625	+0.004, -0.003	10

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in (mm)	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in²	Flow Cross Section in²	Volume per unit Length gal/1000 ft	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.250	0.035	21,166	7,630	0.0236	0.0254	1.3	83.1	827	2,376
0.250	0.049	29,632	10,075	0.0309	0.0181	0.9	108.8	1,083	3,110
0.250	0.065	39,308	12,443	0.0378	0.0113	0.6	132.8	1,322	3,797
0.375	0.035	14,167	5,347	0.0374	0.0731	3.8	131.4	1,308	3,757
0.375	0.049	19,833	7,214	0-0502	0.0603	3.1	176.4	1,756	5,043
0.375	0.065	26,310	9,157	0.0633	0.0471	2.4	222.6	2,216	6,362
0.500	0.035	10,646	4,109	0.0511	0.1452	7.5	179.8	1,790	5,139
0.500	0.049	14,905	5.599	0.0694	0.1269	6.6	244.1	2,430	6,977
0.500	0.065	19,771	7,194	0.0888	0.1075	5.6	312.3	3,109	8,927

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:

Minimum ultimate tensile strength, UTS_{min} and minimum 0.2% offset yield strength, YS_{min} per above table.

Maximum outside diameter, OD_{max} per above table

Minimum wail thickness, t_{min} per above table

Minimum burst pressure = $(2 \times t_{min} \times UTS_{min}) / OD_{max}$; assumes no axial or other loading except internal pressure.

Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.

The load at typical UTS represents the load to cause failure. Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

www.drakausa.com

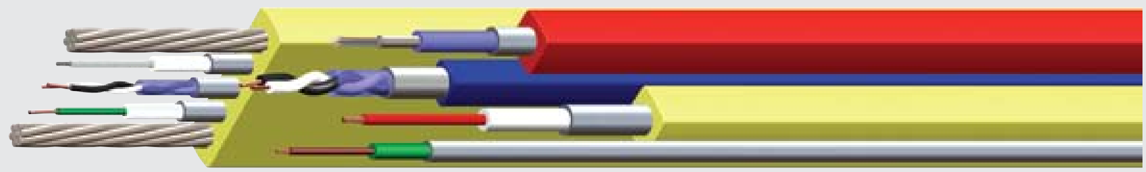
For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com

Draka

Alloy 625 Seam Welded Sheathed Tubing

Cold worked / 115 ksi minimum yield strength

UNS N06625



Applications

Alloy 625 seam welded sheathed tubing, which is commonly referred to as TEC, is typically used in oil, natural gas and geothermal wells to provide power and communication to down-hole gauges. TEC contains a core consisting of insulated electrical conductor(s) and/or optical fiber(s). The tubing is generally deployed by strapping it to the outside of the production casing. However, it may also be free hanging (self-supporting) inside the production casing. It may be encapsulated and can be included along with pressure tubing and mechanical components, such as bumpers, within a flatpack. The tubing is frequently supplied as 5,000 to 35,000 ft. coils on a wooden or steel reel, depending on size.

Description

Alloy 625 is an austenitic nickel - chromium - molybdenum - niobium alloy (see Table 1 on reverse). The high alloy content enables alloy 625 to withstand severe aqueous corrosion environments. High molybdenum content (8.0 to 10.0%) makes the alloy very resistant to chloride pitting and crevice corrosion. High nickel content (58.0% min.) provides relative freedom from chloride ion induced stress-corrosion cracking. Alloy 625 has shown excellent corrosion resistance in oil and gas environments containing hydrogen sulfide, carbon dioxide and chlorides. Consult ISO 15156-3, Table A.14 for the limits regarding material type 4d in hydrogen sulfide containing environments for oil and gas production. Draka uses expert system software to assist customers in their selection of alloys for oil and gas environments.

Manufacturing Process and Resultant Properties

Strip splice welds, which are used to join lengths of cold rolled strip, enable long continuous lengths of tubing to be manufactured. The strip is formed into a tubular cross section around the core and longitudinally seam welded using the gas tungsten arc welding (GTAW) process. The tubing is seam welded at a larger outside diameter to protect the core and then sunk to final size. The final material condition of the tubing is cold worked. Mechanical properties, permissible variation in tubing dimensions and size dependant characteristics / properties are listed in Tables 3, 4, and 5 on reverse respectively. It should be noted that due to the rapid rate at which alloy 625 strain hardens (cold works), it may not be possible to meet the ISO 15156-3 limits on maximum yield strength and hardness.

Nondestructive Testing (NDT)

In-process eddy current testing (ECT) is performed on the as-welded tubing and final ECT is performed on the as-sunk tubing. Visual examination is performed on all ECT indications. Performance of additional NDT is dependent upon both the type of core and specific customer requirements, and may include: electrical continuity, high voltage/bending, insulation resistance, optical time domain reflectometer, and high pressure nitrogen underwater.

Standards and Specifications

Tubing Specification PTM-TS-019, Alloy 625 Sheathed Insulated Electrical Conductors and Optical Fibers

ASTM B704, Standard Specification for Welded UNS N06625, UNS N06219 and UNS N08825 Alloy Tubes

019 625 W ST 0311 19

Alloy 625 Seam Welded Sheathed Tubing

Cold worked / 115 ksi minimum yield strength

UNS N06625

Table 1 - Chemical Composition, UNS N06625 with further restrictions by Draka Strip Specification, PTM-SS-004, (%)

C	Mn	Si	P	S	Cr	Nb + Ta	Co	Mo	Fe	Al	Ti	Ni
0.05 max	0.50 max	0.50 max	0.015 max	0.015 max	20.0 - 23.0	3.15 - 4.15	1.0 max	8.0 - 10.0	5.0 max	0.40 max	0.40 max	58.0 min

Table 2 - Typical Physical Constants and Thermal Properties

Density (lbs/in³)	0.305
Modulus of tension elasticity (x10⁶ psi)	29.8 at 70º F 28.4 at 400º F
Mean coefficient of thermal expansion (in/in/ºF x 10⁻⁶) from 70º F to temperature shown	7.1 to 200º F 7.3 to 400º F

Table 3 - Mechanical Properties

Property	Minimum	Typical
Ultimate Tensile Strength UTS, (psi)	150,000	160,000 to 180,000
0.2% Offset Yield Strength, YS (psi)	115,000	130,000 to 150,000
Elongation in 2 inches, E (%)	—	3 to 8
Rockwell Hardness, HR45N (45 kg load)	—	47 to 48
Vickers Hardness, HV5 (5 kg load)	—	335 to 390

Notes: Typical properties vary with the amount of cold work. Vickers Hardness testing was performed on the inside surface of the tubing in a base metal region. Vickers Hardness testing was performed in weld metal and base metal regions on mounted cross sections.

Table 4 - Permissible Variation in Tubing Dimensions

Dimension	Permissible Variation
Nominal Outside Diameter (in)	± 0.002
Nominal Wall Thickness 0.022-in.	0.0200 to 0.0225
Nominal Wall Thickness 0.028-in.	0.0255 to 0.0285
Nominal Wall Thickness 0.035-in.	0.0315 to 0.0355
Nominal Wall Thickness 0.049-in.	0.0445 to 0.0495

Table 5 - Size Dependant Characteristics / Properties (based upon nominal tubing dimensions)

Nominal Outside Diameter in (mm)	Nominal Wall Thickness in	Minimum Burst Pressure psi	Minimum Collapse Pressure psi	Metal Cross Section in²	Weight per unit Length lbs/1000 ft	Load at Minimum 0.2% YS lbs	Load at Typical UTS lbs
0.125	0.022	47,244	30,516	0.0071	26.1	819	1,210
0.125	0.028	60,236	36,909	0.0085	31.2	981	1,451
0.1875	0.035	49,868	31,877	0.0168	61.4	1,928	2,851
0.250	0.028	30,357	20,919	0.0195	71.5	2,246	3,320
0.250	0.035	37,500	25,156	0.0236	86.5	2.719	4,019
0.250	0.049	52,976	33,443	0.0309	113.2	3.558	5,260
0.3125	0.049	42,448	27,939	0.0406	148.5	4,665	6,896
0.375	0.035	25,066	17,612	0.0374	136.8	4,299	6,355
0.375	0.049	35,411	23,944	0.0502	183.7	5,771	8,531

Notes Regarding Burst and Collapse Pressure

Minimum internal burst pressure and external collapse pressure calculations were based upon:

Minimum ultimate tensile strength, UTS_{min} and minimum 0.2% offset yield strength, YS_{min} = per above table

Maximum outside diameter, OD_{max} per above table

Minimum wall thickness, t_{min} per above table

Minimum burst pressure = $(2 \times t_{min} \times UTS_{min}) / OD_{max}$; assumes no axial or other loading except internal pressure.

Collapse pressure based on API 5C3; assumes no ovality, internal pressure or other loading except external pressure.

Notes Regarding Load at 0.2% YS & UTS

The load at minimum 0.2% YS represents the load at which 0.002 in/in of plastic (permanent) axial strain deformation has occurred.

The load at typical UTS represents the load to cause failure. The UTS used in the calculation of the load at typical UTS was 170,000 psi.

Decisions regarding the pull out load to be applied to tubing should consider these two loads.

The data herein is approximate and subject to normal manufacturing tolerances. These specifications are subject to change without notice.

019 625 W ST 0311 20

Draka Engineered Specialties | Specialty Tubing
111 Chimney Rock Road | Bridgewater, NJ 08807 | Tel +1-732-469-5902 | Fax +1-732-469-6363

www.drakausa.com

For sales and technical information, contact:
Draka Engineered Specialties | 1-866-786-8823 or 1-732-469-5902 | www.drakausa.com