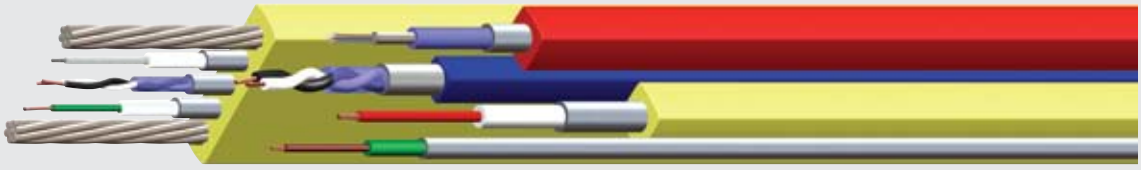
# Alloy 625 Seam Welded Sheathed Tubing

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

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**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$^{-6}$) | 7.1 to 200º F |
| from 70º F to temperature shown | 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 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 | 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.

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