
Tungum[®] Alloy Tubing



Article supplied by T2 Alloys Limited, UK

Saving lives

You lose on average \$500,000 a day if your offshore production platform is out of action. The failure of the hydraulic traverse gear on an MBT could cost one of your colleague's lives. A spark in the oxygen lines on a hyperbaric chamber would be catastrophic.

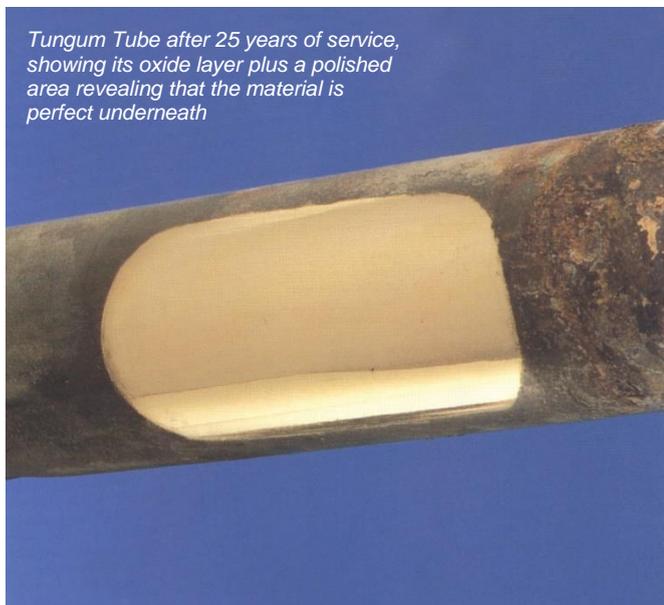
A little too dramatic? T2 Alloys Limited's customers don't think so. This article describes how Tungum[®] Alloy Tubing is the material of choice, working in the above industries for over 80 years.

What is Tungum Alloy Tubing?

Tungum Alloy Tubing (nickel, aluminum, silicon, brass) has excellent corrosion and fatigue resistance properties. It also has an unusually high strength to weight ratio, coupled with good ductility.

When used in high pressure hydraulic or pneumatic circuits, these features together with inherent 'clean bore' characteristics combine to give a cost effective, easily constructed, long lasting and high integrity system. When built, the systems require a minimum of purging and no external protective treatment.

Tungum Alloy Tubing also has a high proof to ultimate stress ratio, which enables system proof tests to be conducted well above its working pressure without risk of permanent set taking place.



Tungum Tube after 25 years of service, showing its oxide layer plus a polished area revealing that the material is perfect underneath

History

Tungum Alloy was originally produced for decorative purposes, because when it is polished it looks like gold! Tungum has a rich engineering history dating back to the 1930s. Leading up to the start of the Second World War, Vickers designed and built the prototype Wellington Bomber. The design was state-of-the-art, and one of its many great features was that it was to be the first UK-built aircraft to have hydraulically actuated flaps, rudder and landing gear. However, the aircraft had a serious weight problem.

Coincidentally, as the fable goes, a cigarette case manufactured from Tungum Alloy was accidentally crushed when a motorcar ran over it. Even under the car's weight, the case's rounded edges had not collapsed or cracked. A corner of the case was examined, to reveal an excellent and uniform grain structure.

Further mechanical tests indicated that Tungum Alloy had desirable mechanical properties not discovered or appreciated until that time. When drawn into tube with thin wall thicknesses it held the pressure required. This allowed significant weight savings to be made over the available materials at the time. This was the origin of the Tungum Alloy Co Ltd in 1933. The Tungum Alloy manufacturing process was immediately developed so it could be drawn into tubular form for the hydraulic applications needed.

Tungum Alloy's attractive appearance and traditional decorative applications soon gave way to more practical solutions. Over the following decades the appreciation of the material's physical properties led to many engineering applications. The use of Tungum Alloy Tubing in the Royal Navy for hydraulic systems and other related marine applications showed not only the mechanical benefits of the material but that it exhibits superior corrosion resistance, especially in saltwater applications or areas of high humidity. Since then this has become one of its major benefits to end users.

There have been some interesting and prestigious applications along the way of Tungum Alloy Tubing's development. Such things as the hydraulic pipework for raising and lowering Tower Bridge, the hydraulic systems on the Hurricane and Spitfire aircraft, right through to luxury items such as dive watches from Drass and H₂O.

Corrosion resistance

Tungum Alloy Tubing has a high level of general corrosion resistance, allowing it to be specified for use in systems containing or operating in the presence of a variety of substances and solutions. It possesses a natural protection



*Despite more than 10 years' exposure on a semi-submersible support vessel, Tungum Alloy Tube remains unscathed under the clamp.
The stainless-steel section from a Southern North Sea platform shows four rows of severe crevice corrosion also under the clamp after just four years*

mechanism. Specifically, in offshore applications or areas of high condensation, on exposure to these environments a thin oxide coating is generated over the exposed surface. This layer is approximately 50 microns when complete.

The tube surface grows a verdigris oxide layer and starts to become discolored. As this occurs, it shows that the material's natural protective system is working. Under this oxide layer, the material is perfect and will remain so for its working life or the lifetime of the installation.

As Tungum is a copper-based alloy, many of the industry standard corrosion testing systems are not applicable. This includes PREN, ASTM G48 and CPT. The question then is what corrosion testing is appropriate? One example is NACE Paper No 10305, entitled '316 Stainless Steel Instrument Tubing in Marine Applications – Localized Corrosion Problems and Solutions'. This paper compares various tubing materials in addition to Tungum Alloy (UNS C69100). The materials included were 316L, 317LMN, Alloy 825, 6Mo and Alloy 625. It underpins historical evidence of the successful performance of Tungum Alloy Tubing in these demanding safety critical applications. All of the materials were laboratory tested in a cyclic salt fog chamber to ASTM D5894 at temperatures ranging from 25 to 45°C. Field tests were carried out by exposure to a marine environment for a one-year duration on board two offshore platforms, one located in the Gulf of Mexico and the other in Trinidad.

In both field and laboratory tests Tungum Alloy Tubing was the material that resulted in the best localized corrosion resistance gauged by two of the three visual inspection indicators, namely: pit depth in the body of the tubing and crevice corrosion depth. The conclusion was that Tungum Alloy Tubing is a material that can be safely used in a marine atmosphere, keeping in mind its pressure and internal corrosion limitations. Typical application maximum working pressure of Tungum Alloy Tubing is 5,000 psi. Tungum should be used in non-process applications and should not be used in the presence of ammonia, acetylene and mercury.

The other key determinant of suitability for offshore and other applications prone to crevice corrosion and pitting is the approval of key players in the market. BP has approved

Tungum Alloy Tubing for non-process applications. Having passed extensive testing Tungum Alloy Tubing is segment defined for mitigating and preventing external corrosion on topside non-process small bore tubing.

Applications

Tungum Alloy Tubing has been used in a multitude of applications across numerous industries for over 80 years. Three of the major sectors where Tungum Tubing is widely used are oil & gas, defense, and in saturation diving.

Oil & gas sector

Tungum Alloy Tubing has been in use offshore since the mid-1970s for non-process applications. It is also used extensively for oxygen lines due to its inherent non-sparking characteristics. Industry awareness of its superiority for use in marine environments is increasingly evident as more and more operators question the use of stainless steel from both safety and economic viewpoints. Tungum performs at the highest level and is by far the most cost-effective option when competing with austenitic and Super Duplex alloys. Clearly it is about choosing the right material for the right application.

Tungum Alloy Tubing is compatible with all industry standard fittings. Almost any industry recognized 316 stainless steel instrumentation fittings can be used in conjunction with Tungum Tube. Typically, this is the twin ferrule type fitting.

Tungum Alloy Tubing has been used extensively on marine and non-process systems on BP's PSVM FPSO that was built at the Jurong Shipyard, Singapore. Having been specified in accordance with BP global practices for this type of usage, it was important to have the support of the engineering team during the build phase to endorse the ease of installation of this material. As part of the feedback given by the MODEC engineers and their team at the shipyard, there were no issues with installation, bending and assembly. All the joints were made first time. Local stock availability was vitally important to ensure that the project ran smoothly.



Stainless steel tubing exhibiting pitting corrosion

When additional material was needed, it could be sourced without delay. T2 Alloys Limited's distributor in Singapore, Global Hydraulics Pte Ltd, was able to respond quickly to these operational demands.

As Tungum Alloy Tubing is amongst the high-quality grouping of super alloys, there is no doubt that it is more costly than 316 or 317 stainless steel. However, this is more than compensated for through the whole 'lifetime cost' argument.

Engineers on the latest offshore projects are looking for at least 25-30 years of operational life. Tungum Alloy Tubing does not need replacing in this timescale. When comparing this to stainless steel, you can expect around 5-7 refits over the life of an asset. By using Tungum there are significant savings on downtime, costly refits, plus material disposal; the material has become a cost-effective tubing option, as well as a strong benefit to the environment. T2 Alloys Limited uses the expression '30 to Life', as the material has a proven track record in offshore applications spanning at least 30 years.

Defense sector

Tungum Alloy Tubing is utilized heavily in the defense sector. It is primarily used in hydraulic and pneumatic systems. Applications include climatic control circuits, brake pipes control and fuel lines. The primary reasons for using Tungum Alloy Tubing are its ductility, high fatigue resistance and excellent corrosion properties.

The British Army has specified Tungum Alloy Tubing in its fighting vehicles to the extent that virtually every major vehicle built in the past 50 years has used Tungum Alloy Tubing. The tubing, mainly connected using soldered fittings, is used for hydraulics associated with the hydrostatic drive system, gun loading and deployment circuits.

There can be no more physically arduous hydraulic application than in a tracked fighting vehicle. The tubing must endure mechanical vibration from the engine, hydraulic ripple from pumps, hydraulic shocks from traversing uneven ground and obstacles, mechanical shock from the gun firing and, in the worst case, being hit by an incoming shell or IED. Battlefield survivability is of paramount importance and UK-built tanks, including the latest Challenger 2 class, amply demonstrate this.

BAE's AS90 155mm tracked howitzer and the US M777 upgrade are typical examples of the continued use of Tungum Alloy Tubing in modern warfare equipment. Abroad, the Swedish-built Bofors guns have a long history of Tungum use, including the hydraulic traverse gear and auto-load systems on mobile and static guns, such as the Bofors 'Trinity' and Archer FH77.

Hyperbaric chambers

Tungum® Alloy Tubing is ideal for use in hyperbaric chambers. Its non-sparking feature is a must when in contact with oxygen. It also exhibits excellent antimicrobial characteristics as it contains >81% copper.



A Drass hyperbaric chamber showing the gold colored Tungum Alloy Tubing used due to its non-sparking characteristics and excellent corrosion resistance

Clients include Drass, JFD, Unique, Subsea 7, Sealion and Lexmar, to name but a few. For example, Submarine Manufacturing Ltd utilizes Tungum Alloy Tubing in the build of its hyperbaric chambers, and not just for its non-sparking qualities. As part of the range of industry sectors it services, Submarine Manufacturing Ltd sells chambers to the medical industry, referred to as hyperbaric oxygen therapy chambers (HBOT). By using copper-based alloys it can help to inhibit the growth of harmful pathogens – bacteria, molds, algae, fungi and viruses. As we know, in recent times hospitals have come under ever increasing scrutiny due to outbreaks of potentially deadly bacterial infections such as MRSA, Legionnaire's disease and E. coli.

A hyperbaric medical chamber from Submarine Manufacturing was installed for NHS Orkney using Tungum Tubing both inside and out. Supporting the antimicrobial benefit of copper-based alloys like Tungum Alloy, the Copper Development Association (CDA) has been carrying out clinical trials at Selly Oak Hospital in Birmingham. It concluded that the use of copper and copper-based alloys reduces the number of micro-organisms contained on them by 90-100% when compared to other materials currently used.

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