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NOTES ON TUNGUM ALLOY TUBE AND OXYGEN SERVICE

The attached notes present a strong case for the use of TUNGUM ALLOY instead of many other materials (including stainless steels) for the transmission of Oxygen.

Its high strength, ductility, excellent resistance to corrosion and vibration/shock, combined with its inherent safety features make TUNGUM ALLOY the preferred tube material for Oxygen Systems.

Approved by: Ruben Muro

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TUNGUM ALLOY TUBING AND OXYGEN SERVICE

Statistical evidence gathered in the U.S.A., in the early 1970's, indicated that more than 50% of all mishaps to Oxygen Services had, as a contributing factor, short-comings in material selection for the system itself.

Additionally, analysis of mishap frequency showed that during the period January 1968 to May 1971, U.S. Navy installations suffered at a rate equal to one every 4 weeks.

Since the potential for ignition is inherent, in even the most carefully constructed system, it follows that material compatibility is a factor of great importance to operational safety.

POTENTIAL IGNITION SOURCES:

1} Rapid heating due to adiabatic compression at points of reduction in "flow" area.
2} Impact of particles carried in the flow stream against the tube surface.
3} Frictional heating affects.
4} Static discharges.

TO BE COMPATIBLE WITH OXYGEN SERVICE, A MATERIAL SHOULD HAVE:-

A} The physical strength to contain the pressure of the system itself.

B} The best combination of thermal properties, to minimise the risk of initial combustion taking place: -

- *i} A high ignition temperature. (Most metals, save for Silver and Gold, are combustible as are plastic materials).*
- *ii) A high thermal conductivity – greatly assists in dissipating the heat generated by the system, and hence reducing the risk of the ignition temperature being reached.*
- *iii) A high thermal diffusivity greatly assists in the avoidance of "hot spots" resulting from adiabatic compression. Again reducing (if not totally eliminating" the risk of the material reaching the ignition temperature.*
- *iv) A relatively low heat of combustion – has a significant bearing on the rate at which an initial ignition propagates and hence the proportions of any such mishap.*
- *v) Other factors influencing compatibility are specific heat and density. These, however, are of lesser importance when the material selected substantially satisfies (i) to (iv).*

C} Since it is essential that Oxygen Systems are especially clean and free from all grease or oil film, it follows that an inherently clean material will assist greatly in simplifying the cleaning operation.

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NOTES ON TUNGUM ALLOY TUBE AND OXYGEN SERVICE

A COMPARISON OF STRENGTH/THERMAL DATA FOR VARIOUS MATERIALS

MATERIAL	*Tensile Strength of Tubes (N/mm^2)*	*Melting Temperature (^0K)*	*Ignition Temperature (^0K)*	*Thermal Conductivity @ 300^0K (W/cmK)*	*Thermal Diffusivity @ 300^0K (cm^2/Sec.)*	*Heat of Combustion (j/g)*
TUNGUM	*478×10^6 (mean)*	*1283*	*1273 **	*1.00*	*0.074*	*3000 Approx*
STAINLESS STEEL	*553×10^6*	*1430*	*1400 **	*0.15*	*0.010*	*8000 Approx*
TEFLON	*Immediate on own*	*600*	*700 **	*0.002*	*0.002*	*1100 Approx*
NYLON	*Immediate on own*	*500*	*475 **	*0.003*	*0.002*	*7000 Approx*

*** See Note (i)***

From the above it will be seen that: -

1} ***TUNGUM ALLOY*** *has a strength almost equal to that of Stainless Steel 316 and many times that of plastics. Also, per ASME B31.3, Tungum and Stainless Steel 316 have the exact same allowable stress which means the pressure calculations are the exact same.*

2} ***TUNGUM ALLOY*** *has a most satisfactory combination of thermal characteristics: -*

(i) Its ignition temperature being of a relatively high order, well above that of even the best plastics and close to that of stainless steel.

(ii) The short fall in ignition temperature (relative to stainless steel) is compensated for (many times over) by ***TUNGUM'S*** *vastly superior thermal conductivity/diffusivity. Both factors are approximately 7 times better than stainless steel, and, even more significantly, above that of Teflon or Nylon. These are the factors governing the likelihood of the ignition ever being reached.*

(iii) ***TUNGUM'S*** *heat of combustion is less than 50% of that for stainless steel, and, by volume, relatively lower than plastics since the physical strength of plastics is so inferior.*

(iv) ***TUNGUM*** *is a non-sparking material, such that risks from impact are eliminated.*

3} ***TUNGUM*** *has an inherently clean bore, making the essential "purging" operation that much simpler.*

NOTES

{i} *All materials, save for Silver and Gold, have a critical ignition temperature and, hence, are capable of burning. This temperature varies with pressure up to 2000 psi, but above this figure is relatively more stable at higher pressures.*

The foregoing ignition temperatures quoted are for relative comparison purposes only and are not intended to be absolute design figures.

(ii) *In addition to material selection, it should also be understood that system cleanliness, flow rates, pressures, and a design, free from obstructions/tight bends, also have a significant part to play in the safety of Oxygen Systems. It naturally follows that the Designer should satisfy himself as to these factors, as only he will have the intimate knowledge to do so.*

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