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# C94700 HEAT TREATED SPINODAL BRONZE

C94700 HT Nickel Tin Bronze as a distinct advantage over other high strength copper alloys that have similar mechanical properties.

The tin content of this alloy attracts the polar lubricant molecules and this alloy performs better as bearings and wear plates than do manganese bronzes and aluminum bronzes. Wear tests have proven that C94700 HT wears at less than half the rate of beryllium copper and aluminum bronze.

The C94700 wear film, deposited on mating steel parts, results in very low coefficients of sliding friction. Aluminum bronze, manganese bronze and beryllium copper all have abrasive precipitates or abrasive crystal phases that are absent in C94700 HT. C94700 HT is a single-phase alloy. The strength comes from the spinodal structure, which is an ordered arrangement of the nickel and tin atoms in waves only millionths of an inch in length.

Boundary lubricated wear tests of C94700 HT spinodal bronze indicates an unusual phenomenon, previously unseen. At a given speed, if the load is increased, the bearing actually, wears less and the system operating temperature decreases. Some explanations of this interesting property are:

- Bearing asperities break off and stress is lowered due to increased contact area.
- Work hardening takes place on the bearing surface.
- Some elastic interaction in the spinodal structure begins to operate at high loads.

No other bearing alloy will duplicate this behavior. Since the strength of this alloys comes from its composition and heat treatment, it is possible to make very large parts, with high strength, that cannot be extruded, forged or cold worked.

The precipitates or hard phases in the other copper alloys represent areas where fatigue cracks will initiate. This limits their ability to withstand cycles of bending or torsion loading. The single phase C94700 HT is superior to those alloys in fracture toughness.

Another attractive property of C94700 HT is its corrosion resistance. The tin and nickel content of this alloy makes it suitable for marine applications as well as the corrosive environments encountered in oil and gas well drilling.

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The reason behind the excellent physical properties of spinodal alloys was discovered only after the invention of the electron microscope. Being able to view the microstructure at 100,000 magnifications revealed a layered texture, the layers only being several atoms in thickness. This structure is obtainable as a result of aging after solution treating to cause what is called spinodal decomposition. The layers of slightly different composition come from a movement of the solute atoms during the aging process. This small difference is not a large-scale diffusion to form precipitates which is the normal strengthening action in precipitation hardening alloys. Spinodal decomposition is possible when all the different metal atoms are nearly the same size and can form a completely homogeneous solid solution.

Since some spinodal alloys may actually create precipitates upon slow cooling from the solid solution, it may be necessary to quench those metals from the solid solution temperature. The desired atomic shift can then be affected by aging at a lower temperature to allow the crystals to strengthen by atoms of one kind to move to areas of higher concentration without forming a precipitate.

The unique C94700 HT properties suggest applications in hydraulic pump cylinder heads (no need for cylinder sleeves), heavy vehicle bearings, wear plates for stamping presses and many other applications. C94700 HT bronze presents new possibilities to equipment designers when a combination of high impact strength, fatigue resistance, toughness, low wear and corrosion resistance is required.