Bronze and Copper-Alloy Bearings

Dozens of copper alloys are available as bearing materials. Most of these can be grouped into five classes: copper lead, copper tin (sometimes called tin bronze), leaded bronze, aluminum bronze, and beryllium copper.

As a general rule in these alloys, a higher lead content promotes compatibility with soft alloy shafts and reduces friction in low-lubrication conditions (start-up, for example) while slightly sacrificing wear resistance. Thus, copper lead and leaded bronzes are often used where compatibility outweighs the effects of lower mechanical properties. Other alloying elements are added to copper to tailor an alloy for user requirements based on load capacity, bearing strength, hardness, wear resistance, and fatigue strength.

Compared with the softer babbitts, copper-alloy bearings provide greater load capacity, better high-temperature operation, greater wear resistance, but poorer scoring resistance.

Copper lead: Since lead is practically insoluble in copper, a cast copper-lead microstructure consists of lead pockets in a copper matrix. These pockets of lead serve as reservoirs for maintaining a continuous lead film on the bearing surface.

With either continuous casting or powder-metallurgy techniques, a steel backing is used with copper-lead bearings for increased strength. These bearings are also frequently used with a babbitt overlay in a three-layer construction. The hardness of copper-lead materials is similar to that of babbitt at room temperature, but is higher at temperatures approaching 300°F. Corrosion of either the lead or copper can be minimized by additives in high-quality automotive and industrial lubricating oils.

Copper-lead systems are used for diesel engines on trucks and off-road vehicles, although aluminum alloys are frequently specified for greater corrosion resistance at a sacrifice of compatibility. Copper lead is used in moderate load and speed applications, such as electric motors, turbine engines, and generators.

Leaded bronze: The 4 to 10% tin content in leaded bronze increases strength, maximum load capacity, fatigue resistance, and hardness above what is available with simple copper leads. Zinc is sometimes used as a replacement for tin, and nickel (or nickel or silver) is often added to improve corrosion resistance and toughness.

Leaded bronzes have better compatibility than tin bronze because the spheroids of lead smear over the bearing surface under conditions of inadequate lubrication. These alloys are generally a first choice for intermediate loads and speeds. They are used in machine tools, home appliances, farm machinery, and pumps.

C93200 alloy is currently the standard cast-bronze bearing material with many suppliers. The 80-10-10 SAE C93700 phosphor bronze is also popular. Its relatively high hardness and good impact resistance make it widely used in steel plants for such applications as roll-neck bearings. It is also used in lathes, instruments, household appliances, diesel rocker-arm bushings, automotive piston-pin bushings, pumps, and trunnion bearings.

Softer C93800, with its higher lead content, offers better compatibility characteristics and good performance where lubrication is doubtful. It is widely used for diesel engine bearings, in cranes, and in railway and earthmoving equipment. It has good antiscoring properties with soft shafts. However, alloys with lead content over 20% are becoming difficult to obtain because they are difficult to cast.

C93200 Bearing Bronze / High Leaded Tin Bronze has excellent machining properties, good hardness, strength and wear resistance with excellent anti-friction qualities. The alloy is not subject to dezincification and has reasonable corrosion resistance to seawater and brine making it suitable for pump and valve components. C93200 bronze is suitable for bearings, bushings having medium loads and speeds with adequate lubrication.

Tin bronze: These alloys have high hardness, thus require reliable lubrication, good alignment, and a minimum Brinell shaft hardness of 300 to 400. They are used in high-load, low-speed applications such as trunnion bearings, gear bushings for off-road vehicles, rolling-mill bearings, and in internal combustion engines for connecting-rod bearings, valve guides, and starters.

Cast-bronze bearings offer good compatibility, casting, easy machining characteristics, low cost, good structural properties and high load capacity. They do not require a separate overlay or a steel backing.

Aluminum bronze: Bronzes of high strength are obtained by using aluminum, iron, manganese, silicon, and nickel as alloying elements. Such bearings have excellent shock and wear resistance. They retain high strength at high temperatures and are used in equipment operating above 500°F. A major use is in high-impact sliding surfaces in aircraft landing gear.

Because aluminum bronze has poor compatibility, embeddability, and conformability, it is best suited for heavy-duty, low-speed applications with plentiful lubrication. Aluminum bronzes require harder shafts than softer bearing materials. Proper alignment is more critical because of low conformability.

Aluminum Bronze C63000

Specs: AMS 4640, ASTM-B-150, ASTM-B-124, QQ-C-465
UNS# C63000

Aluminum Bronze C63000 and C63200 are similar in their chemical composition, predominantly a Copper alloy (77-93%) with Aluminum, Nickel, Iron, Manganese and Silicon. Unlike C63200, C63000 is not heat treated, but annealed only.

Aluminum Bronze C63000 has a strong, corrosion resistant material that performs well at high and low temperatures and also has a low magnetic permeability, making it ideal for instrumentation systems, seawater piping systems and marine propulsion units.

C63000 is commonly used in a variety of aerospace applications for landing gear components, brake components, and static and dynamic bushings, as well as in marine, industrial and automotive applications. Aluminum Nickel Bronze (CuAl10Fe5Ni5) C63000 is an alloy used throughout the world for applications requiring good corrosion and wear resistance.

Used extensively in the aerospace industry for landing gear bushings and bearings, its corrosion resistance, wear, high strength and fatigue properties have all been well proven.

The alloy is found in many applications in the marine environment for fixtures, fitting and components used in seawater piping systems. Because of its good erosion/corrosion properties, it is used for marine propulsion units such as propellers.

C63000 can be joined by using MIG or TIG welding techniques.

In addition, the alloy has excellent wear resistance and good corrosion resistance in fresh and sea water.

It is non-sparking, which is important in explosive environments related to the weapon handling, petrochemical and mining industries

Beryllium copper: Adding about 1.8% by weight of beryllium and about 0.2% cobalt to copper provides an alloy with strength comparable to many steels. The high strength, hardness, and thermal conductivity of the alloy promotes its use in high load bearings, especially where reliability is required under occasional overload, impact, high temperature, or marginal lubrication conditions. These alloys are used in electrically conducting applications and are frequently specified for

Beryllium Copper

One of the highest strength copper based alloys available on the market today is beryllium copper, also known as spring copper or beryllium bronze. The commercial grades of beryllium copper contain 0.4 to 2.0 percent beryllium. The small ratio of beryllium to copper creates a family of high copper alloys with strength as high as alloy steel. The first of the two families, C17200 and C17300, includes high strength with moderate conductivity, while the second family, C17500 and C17510, offers high conductivity with moderate strength. The principle characteristics of these alloys are their excellent response to precipitation-hardening treatments, excellent thermal conductivity, and resistance to stress relaxation.

Applications of Beryllium Copper

Beryllium copper and its variety of alloys are utilized in very specific and often tailor-made applications such as oilfield tools, aerospace landing gears, robotic welding, and mold making applications. Additional non-magnetic properties make it ideal for down-hole wire line tools. These specific applications are the reason this copper is known as spring copper and other various names.

What is the difference between Beryllium and Aluminum?

Physical Properties:

Beryllium: Beryllium is a metallic element with a grayish-white surface; it is brittle and hard (density = 1.8 gcm^{-3}). It is the lightest metallic element that can be used in construction industry. Its melting point and boiling point are 1287°C (2349°F) and 2500°C (4500°F) respectively. Beryllium has a high heat capacity and good heat conductivity.

Beryllium has an interesting property related to x-rays penetration through the material. It is transparent to x-rays; in other words, x-rays can pass through Beryllium without being absorbed. For this reason, it is sometimes used to make the windows in x-ray machines.

Aluminium: Aluminium has silvery metallic luster with a slightly bluish tint. It is both ductile (the ability to make into a thin wire) and malleable (the ability to hammer or press permanently out of shape without breaking or cracking). Its melting point is 660°C (1220°F), and the boiling point is 2327-2450°C (4221-4442°F).The density of Aluminum is 2.708gcm^{-3}. Aluminum is an extremely good electrically conductor. It is a low-cost material, and engineers try to use Aluminum more frequently in electrical equipment.

Chemical Properties:

Beryllium: Beryllium reacts with acids and water producing hydrogen gas. It reacts with oxygen in the air and forms a protective oxide layer on the surface and prevents the metal from further reacting.

Aluminum: Aluminum slowly reacts with oxygen and forms a very thin, whitish coating on the metal. This oxide layer prevents the metal oxidizing further and rusting. Aluminum is fairly reactive metal; it reacts with hot acids and with alkalis too. For this reason, Aluminum is considered as an amphoteric element (reacts with both acids and alkalis). Also, it reacts quickly with hot water and the powdered form of Aluminum quickly catches fire when exposed to a flame.

Uses:

Beryllium: Beryllium is mostly used in alloys; most popularly with copper. It is also used in manufacturing telecommunication equipment, computers, and cellular phones.

Aluminum: Aluminum is used to produce packaging materials, electrical equipment, machinery, automobiles and in the construction industry. It is also used as a foil in packaging; this can be melted and reused or recycled.

Sources: https://www.machinedesign.com/
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